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Environmental impacts of toxic substances: improving coastal resiliency in Florida

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ENVIRONMENTAL IMPACTS OF TOXIC SUBSTANCES:

IMPROVING COASTAL RESILIENCY IN FLORIDA

by

AARON MANUEL KORMAN

B.S., United States Military Academy, 2011

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Approved by

First Reader

James Baldwin, Ph.D.
Senior Lecturer of Earth and Environment

Second Reader

Robert Kaufmann, Ph.D.
Professor of Earth and Environment

Third Reader

Richard Reibstein, JD
Lecturer of Earth and Environment

DEDICATION

This project is dedicated to my parents, Marshall and Sue, who gave me the opportunity to try it, and to Casey and Brewtus, who taught me how to enjoy life while doing it.

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ENVIRONMENTAL IMPACTS OF TOXIC SUBSTANCES: IMPROVING COASTAL RESILIENCY IN FLORIDA

AARON MANUEL KORMAN

Boston University Graduate School of Arts and Sciences, 2021

James G. Baldwin, Senior Lecturer of Earth and Environment

ABSTRACT

Anthropogenic effects are causing significant environmental degradation, and regardless of actions taken to mitigate further changes, humans and animals will have to live with these impacts (IPCC 2019). Rapid population growth in coastal regions, saltwater intrusion (SWI), lowering water quality, and increased presence of toxic materials are degrading coastal resiliency. An important and popular coastal region for the United States is the state of Florida, and it is also an area extremely vulnerable to aspects of climate change such as sea-level rise (SLR) (Noss 2011). This project analyzes how the state is currently experiencing the direct and indirect impacts of toxic materials. It will do so through analysis of the performance of federal legislation created with the intent to protect human and environmental health, quantification of current rates of using toxic chemicals and potential pollution, as well as quantifying effects of harmful algae blooms (HAB) on Florida’s housing market.

It was anticipated that legislation such as the Safe Drinking Water Act (SDWA) and the Emergency Planning Community Right to Know Act (EPCRA) would be strictly enforced to ensure drinking water standards and prevention of

toxic pollution in the vulnerable region. Also that natural phenomenon such as the harmful algal blooms significantly impacts the housing market through lowering housing prices in coastal counties.

This project found that the SDWA is not being enforced, EPCRA data shows a huge risk to potential exposures, and that algal blooms are significant to housing prices in the state. Using these scientific findings to improve policy and appropriately communicate complex scientific topics to the public is extremely important. Doing so will enable a higher level of coastal resiliency as communities learn to understand current impacts and better live in a degrading environment in conjunction with continuing efforts to mitigate it.

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SECTION 1. INTRODUCTION

The scientific community has formed a consensus that the impacts of anthropogenic actions negatively affect the global climate system. The Intergovernmental Panel on Climate Change (IPCC) stated in their 2019 report “The Ocean and Cryosphere in a Changing Climate” that these effects are unavoidable (IPCC 2019). In order to establish these claims, the IPCC estimates sea level rise (SLR) by using representative concentration pathways (RCPs) as scenarios with differing levels of emissions, land uses, and mitigation or adaptation actions. RCP2.6, the more conservative model, estimates a SLR of 0.43 meters by the end of the century. This estimation is likely no longer feasible, and higher amounts of SLR are expected. It is more likely that we experience SLR similar to the less conservative estimates of RCPs 4.5, 6, or 8.5 which include SLRs of up to 0.84 meters (IPCC 2019). SLR is just one of many effects of a changing climate that the IPCC and other institutions use as tools to conduct analysis and inform decisions. Others tools concern both mitigation and adaptation.

One mitigation tool is the focus on decreasing emissions in order to slow global warming. The current international goal is to limit atmospheric warming to no more than a two degree Celsius increase in global mean temperature. This symbolic goal from the Paris Agreement in 2015 is unfortunately unlikely, since meeting this goal requires significant changes the very near future (Gomez-Echeverri 2018). It will be the coastal regions of the world to first deal with changes such as SLR. Better understanding a degrading environment is paramount as we move further into the 21st century. The resilience of a region to climate change is dependent on both natural and human dimensions. Coastal resiliency stems from multiple social, political, economic, and environmental factors. I plan to analyze the impacts of a degrading environment in Florida to improve coastal resiliency through action and policy.

Potential anthropogenic reasons for the deteriorating environment were formalized fifty years ago with the first IPCC report stating, “Emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gasses: carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide” (IPCC 1992). After decades of this knowledge, we still have many roadblocks and we have not been able to effectively combat these problems. Our formal reactions have been sporadic and ineffective policy changes at the international level. Progress began with the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, and although efforts have continued with further climate change conventions in Kyoto, Copenhagen, and Paris we are not where we need to be as a global community. We need drastic improvements and much more action taken to improve negative trends. Unfortunately, the environmental policy is not on pace with climate science.

The IPCC estimated in 2019 that in the next thirty years approximately one billion people will reside in locations that are less than 10 meters above sea level (IPCC 2019). Newer research, based on improved digital elevation models

(DEM), suggests the IPCC underestimated and we already have one billion people living less than 10 meters above current high tide lines (Kulp 2019). Coastal ecosystems have always provided adequate space to support their inhabitants' livelihood and economic progress. Through development of aquatic-based trade and professions, as well as and enabling travel and commerce, coastal environments have consistently been desirable for people to live in.

Preparation for climate change is continuously improving through refining estimates of regional impacts of global trends to better understand human interaction with the environment. This preparation will not be uniform, as regions behave differently based on local characteristics and the time scales analyzed. A 2012 study finds that although global and annual rainfall levels increased, regional precipitation levels fluctuated as a function of unpredictable regional air circulation. Also, that temperature is much more predictable than precipitation and there is more variation at interdecadal scales than inter-century scales (Giorgi 2002). Another study in regional analysis shows the ability of regional climate models to accurately represent seasonal temperature changes out to the end of the century for the Northeast United States (Rawlins 2012). This study used regional climate models (RCMs) from the North American Regional Climate Change Assessment Program (NARCCAP), which is conducting research at regional or state levels useful for policy creation and analysis. Programs are including RCMs more often with GCMs to improve forecasts and modeling, bridging the gap between global climate trends and regional impacts. Although these examples of regional focus show a better ability to forecast impacts of climate change, regional perspective can be misleading due to the heterogeneity of many effects. Different environments could improve, relatively, or become more efficient in a warmer climate (Xu 2017). This potential benefit could be reason for inaction or lower motivation towards combating climate change. Additionally, these geographic differences – when considered favorable - can harden disbelief and skepticism towards climate change (Kaufmann 2019). I believe a large regional perspective is needed to show dominant trends that are necessary to completely understand the problem and persuade the public to invest in solutions at local levels and act for the same political at higher levels.

In the United States the cooperative federalism structure is important to benefit from regional analysis and action. Despite no federal level plan to curb emissions over the past years, there are many regional entities that are taking action to fill the gap. Additionally, a new administration and Congress will hopefully reverse this trend. With respect to efforts in decreasing emissions, regional actors are compensating for inaction at the federal level, and we have compensatory rather than cooperative federalism (Thompson 2011). For example, California's actions to prevent climate change is significant to the world as many people and institutions are following suit. California has consistently been at the forefront of higher emission standards in vehicles under the Clean Air Act (CAA) and a consistent state leader in climate change policy (Mazmanian 2020). They have also actively participated in a regional emissions trading scheme for over ten years. Leaders such as California and others like the Regional Greenhouse Gas Initiative (RGGI) and Midwestern Greenhouse Gas Reduction Accord (MGGRA) are good state and regional examples of action. Even near immediate efforts at state, regional, and international levels to stop emissions now will not stop current climate change effects. Estimates anticipate sea-level would still rise approximately 0.5 meters given current conditions don't change. This also brings importance to a concurrent focus on climate change adaptation (Kulp 2019). Multiple studies such as Jackson 2016 are re-analyzing the last 100 years of SLR to better understand and refine relative SLR with increased focused on local areas and smaller scales into the next century (Jackson 2016, Dangendorf 2017, Hay 2015).

Avoiding a limited focus on relative SLR is important. Other physical factors of climate change that must be considered are storminess, land recession, and seasonal factors such as El Niño. All these factors add to the uncertainty of estimating climate change (Reguero 2015) but are only in the physical component and do not account for the social and economic components. These include estimated increases in population due to systematic migration to coastal regions, economic impacts at local and state levels, and the public's understanding and responses to environmental issues and their actions. Increasing risk clearly has not been a deterrent to living on the coast. While there are thematic similarities of coastal regions, each coastal region has different characteristics to include its geography, inhabitants, economy, and culture (McFadden 2007).

We must increase our efforts in preparing for all scenarios. Every centimeter of SLR that we can mitigate in the long run is just as important as every centimeter of SLR we are prepared for in the short run. The reward of preparedness will be heathier ecosystems, healthier economies, and lives saved, leading to increased coastal resiliency. We must have more aggressive and efficient efforts to create a long-term adaptation lifestyle (Brown 2014). To improve coastal resiliency this project attempts to better understand human and environmental interactions. Additionally, many images or highlights used to describe climate change or a degrading environment seem distant and many people aren’t connected to the science. I chose to focus on something all people can't internalize and can be communicated easily. Water and shelter are basic necessities to all, and quantification of drinking water performance and house prices can be communicated to the general public to better inform them and inspire action for change.

I will explore interactions between humans and the environment by analyzing their direct and indirect impacts. To understand the direct effects, this project evaluates the quality of Florida’s drinking water and quantifies potential toxic pollution issues in the future. To understand the indirect effects, this project explores the relationships between harmful algae blooms and their negative economic externalities in the housing market. This project has three parts. The first section, the direct impacts, will consider Florida's ability to enforce the Safe Drinking Water Act (SDWA) in the face of threat such as saltwater intrusion (SWI) and septic pollution. Also, it will explore data submitted through the Emergency Planning and Community Right to Know Act (EPCRA) to quantify potential problems of exposure in the future to identify weaknesses and prevent spills. The second section, the indirect impacts, will focus on the relationship between algal blooms in Florida and try to better understand their farther reaching, and less studied, impacts on the human environment in the state. The third section will bring together the findings from the first two sections and recommend actions to improve the region's coastal resiliency.

For Section 1, efforts to control toxic and hazardous materials began in the environmentally focused 1960's and 1970's. Multiple regulations enacted in a coordinated effort to control toxics and hazardous wastes and materials were ratified during this time. Significant ones were the Toxic Substances Control Act (TSCA 1974), EPCRA in 1986, and the SDWA in 1974. All of these resulted in drastic reductions in both human exposure to risk and our environmental impacts (Sasso 2014). Rising sea levels, increased population rates and other environmental factors are creating many problems for water quality in Florida. Through analysis of both the SDWA and EPCRA, this first section will quantify the water quality problem via data made possible by these acts. Like these direct effects, many toxics have significant indirect externalities that are often not appropriately captured or understood. These indirect impacts will be investigated using the red tides occurring in Florida.

Indirect effects of toxics on Florida's coasts can be represented in the economic impact that karenia brevis blooms have on the housing markets. Florida has a significant economic base in coastal and water-based tourism and industries, and tourists highly considered the natural environment and its health in their vacation destination decisions (Atzori 2018). If visitors consider it, residents likely do as well. NOAA's definition of a resilient coast is one with systems based on both economic and environmental factors (Sutton 2018). With many significant port cities such as Jacksonville, Key West, and Miami, as well as a large tourism industry, economic impacts for the state are large threats. One study anticipates that Miami has the highest value of assets exposed to coastal flooding by 2070, increasing to a total exposed value of $ 3,513.04 billion (Hanson 2011). I plan to understand if environmental impacts are impacting changes in housing values based on algal bloom presence or severity. A common occurrence in Florida that effects vast coastal areas is red algae blooms. I will analyze their occurrence and dispersion against data about housing sale prices over time as a measure of economic impact and indirect effects of these blooms. Within Florida there were significant harmful algae blooms (HABs) seen in 2003, 2005, 2007 and 2014 in areas such as the region from Tampa Bay to Charlotte which is significantly impacted during fall months (Heil 2014, Amin

2015). I will focus on sales from five counties from 2018 and 2019 and corresponding alga concentrations and estimate a relationship between them.

The third section will synthesize the examples provided and recommend actions to influence coastal action and policy. The science is clear that the potential impacts of our continued inaction are disastrous, and action is not happening fast enough. I will highlight potential changes that communities can make, while recognizing actions appropriate for state and regional actors as well. Trying to change national level action dominated by bureaucracies is slow, requiring finding appropriate opportunities to communicate effectively and promote actions of vital importance.

If the two-degree goal of the Paris Agreement is not met regional authorities and policy makers cannot wait to react to changes in the global climate systems. There is a significant lack of adaptation effort at a global scale and subnational actors will have a large effect on levels of coastal resiliency. That is why I will focus on understanding what the population can digest and can turn into large scale impacts without the necessity of large scale policy change. The new administration is likely to enforce more change and lower levels need to be prepared to follow suit and provide detailed feedback. The coastal regions are dealing with the effects of climate change and we must adapt in a sustainable way to ensure a healthy future. This project is an attempt to improve coastal resiliency and add to the understanding of the complex interactions of humans and our environment.

SECTION 2 DIRECT THREATS TO FLORIDA'S WATERS

SECTION 2.A SALTWATER INTRUSION AND SEPTIC POLLUTION ANALYSIS

The United States coastline is the eighth longest in the world, and Florida provides over 8,436 miles of that coast, almost nine percent (CIA Factbook 2020, NOAA 2020). In Florida, mainly due to its sustained climate and significant coastline on the Atlantic Ocean and Gulf of Mexico, tourism and other coastal-based industries provide most of Florida's growth and money (State of Florida Travel Information 2000). This includes offshore tourism such as snorkeling, animal watching, and boating as well as onshore tourism attractions such as theme parks, golf courses and zoos. Florida's reefs alone provide over $1 billion USD a year. These industries that are dependent on the coastline, beaches, reefs, and traveling tourists are at the largest risk of climate change effects and toxics released into the environment. Toxics are an issue that will challenge Florida's infrastructure, people, and resilience.

This section will focus on the challenges to Florida's waters from both anthropogenic and natural sources of toxic materials. There are many chemicals and compounds that are harmful and toxic to both humans and nature. Toxic materials are defined and managed by the Environmental Protection Agency (EPA) and have been legally controlled since TSCA in 1974. Toxics are a complex and consistent problem with a myriad of sources and effects. To specify the definition used in this project, toxics will be described as chemicals or mixtures of chemicals, whether natural or anthropogenic, that are harmful to humans, animals, or the environment by presence or quantity. This section will use both EPCRA and the SDWA to analyze occurring and potential impacts that toxics have in Florida. Two of the most direct problems are SWI and septic pollution. SWI poses a threat to significant sources of drinking water, and septic pollution continues to degrade groundwater as well as near shore ocean water environments (Langevin 2013). Each is a significant threat to the state's ability to provide clean and usable water to its population over the next century. The specific effects that they have on drinking water, and the quantification of potential releases to the environment follow.

Groundwater in Florida mainly comes from the Floridan Aquifer System (FAS), which extends into South Carolina, Georgia, and Alabama, and changes throughout the state with respect to depth and thickness. It is important to understand aquifer type within the study area as varying sub aquifers will have different capabilities in adapting to SWI (Jorgenson 2012). These heterogenous characteristics such as soil type and depth cause different regions of the FAS to be used for sources of water. The FAS along with the Sand and Gravel Aquifer, the Biscayne Aquifer System, the Surficial Aquifer System, and the Intermediate System create the overall aquifer system for the state (FDEP 2015). Specifically, the Biscayne and Intermediate Systems provide much of the drinking water for very highly populated counties such as Hillsborough, Miami-Dade, Broward, and Palm Beach counties. These counties contain the major cities of Tampa, Fort Myers, Miami, and West Palm Beach respectively (FDEP 2015). Both systems are made of limestone, sand, and other materials that have high permeability, enabling the easy movement of water. Many regions of these aquifers have been at potential risk to SWI from increasing rates of SLR and increasing demands from the growing population for decades (USGS 1977). SWI has the potential to pollute aquifers and contaminate the water used for drinking, industrial, sewage, and other uses (Jorgenson 2012). All these factors show potential for coastal aquifers and limestone reservoirs to experience future degradation and be unsuitable to use as a supply and storage of water in the future. Human action is having clear impacts on the geographic characteristics in southern Florida. Langevin 2013 showed that concentrations of chloride (CL) could raise from 15-640 percent in Miami-Dade and Broward counties and identified that SLR exacerbated by wellfield withdrawals have a large impact on water quality with respect to CL and total dissolved solids (TDS) levels (Langevin 2013). Additionally, the seasonal and drastic increases in demand put extreme pressure on the systems and often lead to water shortages during summer months (Zuurbier 2017).

A 2019 study showed that although short term exposure to higher salinity levels is found to enhance growth rates and productivity of some marine ecosystems, the chronic problems of SLR and SWI significantly decrease ecosystem productivity in the Everglades (Wilson 2019). Many of these ecosystems are threatened by significant regime shifts as salt water is changing properties of the peat soil, such as increasing hydraulic conductivity and lowering soil gas content (Sirianni 2020). SWI is a result of not only increasing SLR, but also a compound effect of more acute impacts such as storm surge. A 2019 study identified the acute storm surge as more significant than SLR while studying biodiversity impacts of encroaching water in the Cape Canaveral Barrier Island Complex (Han 2019). This was done in study of a Category 3 Hurricane, Jeanne, and a stronger storm such as a category 5 could have bigger impacts.

This is not a new problem for the state. The USGS identified decades ago that increased populations in Lee County caused 30,000 wells to be drilled from 1957 and 1977. Withdrawals from many of those wells has continuously increased over the following years. Paradoxically, those wells drilled to provide quality water and support a growing population are a significant cause of SWI to the area exacerbated by larger withdrawal rates (USGS 1977). Due to their vulnerability, many studies are conducted to understand aquifer properties in West Florida. The FAS is the largest carbonite aquifer in the United States (Gaswirth 2006). In Hollywood, Florida the Biscayne Aquifer has moved almost one kilometer from these increased well withdrawals (Maliva 2001). Additionally, a 2006 study highlighted groundwater use and SWI as threats to change the distribution of dissolved arsenic and other dangerous chemicals in the Upper Floridian Aquifer (Haque 2006). A study done in 2016 created a vulnerability matrix for water contamination and found the Lee and Broward County areas to be some of the most vulnerable for the state based on dangerously high nitrogen (N) levels in the aquifers (Cui 2016). Analysis of the SDWA supports continued issues of vulnerability of Palm Beach, Boynton, and Miami-Dade counties and the state at large. Using the Enforcement and Compliance History Online (ECHO) database, an analysis of adherence to the SDWA standards shows the low water quality problem and large threats such as SWI and a lack of enforcement to fix it.

With these large threats it is assumed the state would be consistent in adherence to safety regulations. The SDWA was enacted in 1974 to protect public health by emplacing high standards on water that we drink. The act was groundbreaking progress toward public health and environmental safety and a large part of the environmental era the 1960's. The standards set forward within the SDWA such as maximum concentration levels of certain chemicals, methods for quality control and testing procedures, and water sources to be regulated were all meant to lower the risk of illness or death from drinking unsanitary water (EPA 2020). These are great benefits and protections, if achieved.

Since the SDWA's signing by President Gerald Ford, it has been beneficial to public health, but challenging to enforce (Weinmeyer 2017). The Public Health Service had applicable standards to water wells years before the SDWA. The Public Health Service was created in 1912, and their survey in 1969 to understand water quality better identified a large problem. Their survey showed that only half of water systems that were tested met their standards. The result identified the need for more strict policy was needed, and this began the work towards the SDWA (EPA 2020). The SDWA continues to evolve with technology in the ways we treat, handle, and process our water. It has also grown with identification of hazards to health and our better understanding of chemicals and our environment, such as the Lead Contamination Control Act of 1988. The SDWA has been amended 12 times, as recently as 2016 with the Water Infrastructure Improvements for the Nation Act, and in 2018 with the America's Water Infrastructure Act (Tiemann 2017). This act has three major focus areas of lead testing in school's water, assistance for small communities, and reducing lead in drinking water in general (EPA 2020).

I analyzed at data from ECHO from systems across the state to see compliance and drinking water quality. This portal is meant to look at water system performance with respect to compliance and enforcement of the SDWA standards. It provides very specific data about the water system, specific violations (rules, dates, and time frames) and actions taken to remedy these violations. ECHO's definition of a "small" system is service to 500 people or less, but any system that does not serve at least 25 people or 15 connections is not within the ECHO data base because it is not covered by the SDWA. Many of the systems in Florida are local wells that are difficult to be incorporated into statewide or federal policy, enforcement, and budgets due to the monetary investment required. Florida has 41 very large and 4,377 very small facilities with most of the population getting water from smaller sized systems.

Facing such drastic threats, I anticipated the state to inspect, visit, and remedy issues on a more consistent basis. The problem for Florida is clearly getting worse as coastal populations grow and more people are creating new systems and stressing old ones. In contrast to that expectation, the data says that they not visiting as often as they previously did. Florida has 5,339 public water systems (PWSs) throughout the state of varying sizes and communities served. From 2011 to 2018, the number of systems with site visits went from 4,148 (77% of all PWSs), down to half of that at 2,268 visits (ECHO 2020). ECHO's ability to consolidate the data needed for analysis is crucial, it provides the last three years of compliance data and the past five years of inspection and enforcement data. Yet, data software can only compile data, not contextualize it. From ECHO I gathered that 4,556,701 residents of Florida are supplied by a PWS that has had 12 quarters with violations since 2018. Put simply, almost one quarter of the population has not been given water that met the SDWA standards at any point in the three years analyzed. This clearly shows that they are not enforcing the SDWA effectively.

Moving from state to individual water systems,1,758 PWS had violations during the year 2018, and 120 of those were classified as "serious violators". Data clearly show there is a trend of consistent and lengthy violations to the SDWA standards. Highlighted earlier, the Biscayne Aquifer is vulnerable to SWI and provides drinking water to portions of Palm Beach County; of the water systems with 12 quarters of violations in the ECHO data, Palm Beach County alone has 29 systems serving approximately half a million people. The largest three are the West Palm Beach, Boynton Beach, and Seacoast Utilities Authority facilities which together serve approximately 20% of the county. The West Palm Beach facility has had violations of fecal matter monitoring and reporting in 2011 and the consumer confidence rule in 2016, it also has continuously violated the ground water rule since 2017. The consumer confidence rule is important since it is what connects the residents to information about the water that they receive. The Boynton Beach facility has violated the ground water rule, consumer confidence rule, public notice rule, and the lead and copper rule over the last 10 years and violated the first three consistently for the last twelve fiscal quarters. The SDWA determines requirements for monitoring and testing water sources to ensure they are within compliance. Failures to conduct appropriate testing are considered similar to violations based on contaminants above the maximum concentration levels. These violations, however, should be considered differently and compliance failures should hold different consequences. Implications of low monitoring and enforcement standards are disastrous because not as many violations are caught and water quality is not truly seen for what it truly is.

Because of the well-known and significant vulnerabilities identified in the systems, monitoring violations should carry much more importance and higher penalties. There are potential risks or contaminants within the water that are missed due to infrequent or substandard tests and samples. It also significantly increases the amount of time that people are potentially exposed. With the known threat of septic pollution in these highly populated areas misunderstanding the problem scale could be detrimental to public health. EPA requires many of the water systems to be sampled monthly and only systems that are transitory can sample as low as a quarterly basis (EPA 2020). If a single system does not sample appropriately twice, two months of exposure to health risks are not caught in addition to the time it takes to identify contaminants, come up with and enforce the solutions, and resolve all problems. In 2018, 359 systems were found with 489 major monitoring violations of the Total Coliform Rule, only one of nine sections that are quantified by the Florida DEP (ECHO 2020). Major monitoring violations “means a failure to collect all monitoring samples or a failure to report any monitoring result during a compliance period within the calendar year” (ECHO 2020). In 2018 there were more violations (5,280) than there were actual systems (5,119). 877 (17%) systems in the state were not in compliance with the SDWA during 2018 with at least one violation.

This issue has direct and immediate impacts on the population; everyone needs to drink water and the SDWA established their right to understand the quality of it. Further externalities include a depreciation in the confidence of the water quality that has drastically increased bottle water use. Despite significant recycling this still leads to high environmental impacts (Graydon 2019). This isn’t a single system that is malfunctioning or a single sampling crew, this is a systemic problem across the entire state that needs to be addressed at large. Unfortunately, the cases where one can tell that their water is contaminated based on what it looks like in a glass are rare. This is a problem that can’t be tackled without making the data and issues more widely seen. Luckily, support should be easy to attain because everyone has a stake in their own health and well-being.

SDWA enforcement is one aspect of the problem, another is increasing septic pollution. Sewer use is becoming more popular than the use of septic tanks or onsite sewage treatment disposal systems (OSTDs) now that research is proving them to be non-point sources of septic pollution (Cooper 2016). According to data compiled by the Florida Geographic Data Library, as of 2012 there were a total of over 400,000 new septic tanks in the state that had been inspected by the state's department of health, with likely many more that are not inspected (FGDL 2020). There are multiple studies showing that pharmaceuticals and organic pesticides can transfer from septic systems into groundwater and drinking water and that improper treatment can have long lasting accumulation effects (Yang 2016).

Schaider identified that poor maintenance on aging systems leaked organic compounds and high levels of Nitrogen into domestic drinking water in Cape Cod and identified shallower systems as more vulnerable (Schaider 2016). Leaching from septic tanks is a well-established issue and was the highest reported cause of water contamination decades ago (Yates 1985). In the northeast United States, a study conclusively found OSTD leachate negatively impacting the quality of soils exposed and highlighted the importance of the type of soil treatment area. It also established that climate change via increased temperatures and higher water tables can degrade the ability of soil to remove contaminants, an underlying assumption in the use of OSTDs (Cooper 2016). Within Florida this is a ubiquitous problem and multiple areas are dealing with septic pollution and personal health issues. Contaminated drinking water wells may be linked with a higher risk of pancreatic cancer in Florida as an eight-year study found 551 arsenic contaminated throughout a broad geographic study across the state (Liu-Mares 2013). In the Alafia River, which flows into Tampa Bay in the central west of the state, septic systems and domestic wastewater were found to prove an environmental concern by depositing pharmaceuticals and organochlorine pesticides (OCPs) in the water (Yang 2015). On the eastern coast in Palm Bay, Florida, a 1999 study found that a combination of high-water tables, improper percolation, season, and proximity between septic tanks to drinking water wells lead to 60 wells being contaminated with fecal matter or nutrient loading (Arnade 1999).

One area of Florida that has had significant impacts and negative attention from low water quality standards is the St. Lucie Estuary (SLE). Multiple studies found that OSTDs contaminate the SLE, and its water shed. Specific contaminants are increased in nutrient loading (N and P) and have been found to significantly decrease water quality and lead to harmful algal blooms (Lapointe 2017). Highlighting septic pollution as one source of many, findings from a similar study in the St. Lucie River linked significant HABs to septic pollution in the water (Lapointe 2015). Ye in 2017 again found that the SLE was identified as having Nitrogen pollution partially from OSTDS, and that they could be a predisposing nutrient for HABs (Ye 2017). As a last example, during a 2012 study in the St Johns River Basin, which encompasses the SLE and Indian River Lagoon (IRL), it was also found that 16 domestic drinking water wells exceeded acceptable Nitrate levels and ambient water quality criteria over three years and further established the need for investigation (Ouyang 2012). These studies show issues from long term water movement analysis and identification of a chronic problem, but acute events could be more dangerous.

Acute events have the potential to make profound changes to the environment and water quality in a much faster manner. Studies of Hurricanes Jean and Frances in September of 2004 show that increased rainfall during large storm events increased fecal bacteria from septic tanks and increased presence of dissolved nutrients in the groundwater (Lapointe 2012). Similar studies find that increased urban growth put more pressure on septic tank systems and are well known causes of nutrient and microbial pollution (Howarth 2000, Mallin 2006). Furthermore, this problem is not small scale as pollution from septic systems is seen in the SLE, Florida Keys, and Loxahatchee Rivers (Belanger 2007, Lapointe 1990, Lapointe 1995a/b). These increases in septic pollution established an environment that is conducive to cyanobacterial blooms in 2005 (Lapointe 2012). Additionally, these increased amounts of septic waste continue to increase the risk of large storms inflicting much damage to the septic system increasing pollution. A single event could cause significantly increased amounts of pollution and large toxic release impacts.

Attempting to identify large scales from the septic problem proves to be difficult, however. As described in the studies above, using identified markers or tracing mechanisms in a controlled or lab setting one can identify a specific source or system causing pollution or a specific chemical or affect (Haque 2006, Ying 2012, Yang 2016). Scale brings difficulty to the problem and due to the complexity of subterranean interactions and changing environmental conditions over time and space finding patterns at large scale from failing septic tanks is difficult (Geary 2019).

I used data submitted in accordance with EPCRA to quantify toxic chemicals that are at a high risk of release from the acute events described above. I chose EPCRA data because of the clear reporting standards, the scale problem for septic analysis, and lack of structured and organized geodata for other measures. The next portion will analyze and quantify the potential risk of release of toxic substances to the environment which is a significant potential risk that is building in the background.

SECTION 2.B POTENTIAL IMPACTS – UNDERSTANDING EPCRA REPORTING

In addition to these clear effects that SWI and sewage are having on the environment, and specifically the drinking water in Florida, there is a significantly high risk of impacts from potential toxic releases. EPCRA is a legal mandate for a certain population of users, industries, and producers to report what toxics they are involved with in both type and quantity. The reason EPCRA controls certain chemicals is because of their toxicity and negative impact on the environment if not properly handled or released to the environment. The list of chemicals that users must report on does overlap with other laws such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). Additionally, EPCRA mandates formation of two organizations at the state and local level which are the Local Emergency Planning Committee (LEPC) and the State Emergency Response Commission (SERC) to mitigate effects of toxics by quantifying and locating their use and planning for emergency response. This is an area where improved relationships can improve action at both a regional and local level. Aimed at protecting human health from toxic substances EPCRA is a federal regulation that is enforced through the Florida Division of Emergency Management (FLDEM), with its Technical Hazards Section supporting the SERC and being responsible for the reporting and compliance of the federal regulation. Through coordination with the FLDEM for access to EPCRA reporting data, this section quantifies the risk of potential exposures in 2019. It paints a dangerous picture of what could be released to the environment and highlights the importance of enforcing EPCRA and similar statutes more rigorously.

I received the EPCRA Tier II reporting data for the state of Florida for the year 2019, and analyzed it using ArcMap software. It is important to reiterate that this list of toxic chemicals is only a small part of the total that falls under ECPRA's rules. Each facility that exceeds these thresholds will be referenced as users, and each user can have multiple reports of use of different chemicals. Within the data provided was 34,958 individual entries or chemical uses reported to the FLDEM. This is not 35,000 users, but number of times a chemical meets a certain threshold quantity, there can be and often is overlap of chemicals and users. This qualitative analysis is incomplete, however.

It is critical to understand that even quantifying EPCRA's data is still only a small part of the risk. EPCRA's Tier II establishes a reporting threshold of 10,000 pounds for hazardous chemicals, much lower thresholds for extremely hazardous chemicals (EHSs) and applies to only a certain size of organization. Many locations don't use enough or are too small to be governed by these rules. Those tiers, along with other hazards covered by federal mandates such as RCRA (hazardous wastes) and CERCLA (contaminated sites) compound the risk, along with the non-point sources that continue to emit dangerous substances such as saline water and septic overflow. Their risk is difficult to quantify from a lack of structured reporting such as that which EPCRA provides, more research needs to be done to understand and prevent risk from these other sources. Lastly, these data are reported during 2019 and cover annual, compounding totals.

EPCRA Sections 311, 312, and 313 are the bulk of where it attempts to prevent the release of toxic materials into the environment. Section 311 establishes the need to the clearly identifying the chemicals and highlighting their constitution and rules for storage within the facility on material safety data sheets (MSDS). Section 312 requires the yearly submission of data. By March each year the users must identify and report to their local fire department and their state SERC/LEPCs how much and what chemicals they used or had on site for the previous year. These reports aren't cumulative which means 2019's report does not contain 2018 data, should a chemical be removed, added, or changed. These Section 312 reports to the FLDEM were used for this project. Further, Section 313 establishes the Toxics Release Inventory (TRI) Program which mandates the coordination and publication of data about toxic chemical releases in large quantities, by a smaller set of facilities, to the environments. Contrasting the TRI list (EPA 2020) with the other chemicals and quantities provides contrast to the small portion of the toxics chemical release and impact that this study highlights. The TRI contains a total of 710 chemicals, whereas the consolidated EPCRA, CERCLA, and RCRA list is much larger and applicable to larger quantities (EPA 2020) with approximately 500,000 chemicals consolidated (each chemical can have multiple product names as well). Earlier sections of EPCRA highlight steps and timelines for notification to the response system if there is an actual toxic release into the environment. Lastly, Section 322 enables some users to deny submission of EPCRA mandates due to claiming trade secrets, or not wanting to divulge information about chemicals they use in fear of industry competition.

The 2019 data was analyzed in conjunction with the National River Inventory (NRI), specific local examples of risk, and well heads throughout the state. The National River Inventory, established by the National Park Service from Section 5(d) of the 1968 Wild and Scenic Rivers Act, try to protect rivers that have high value to recreation, scenery, rare animal and plant life, geologic formations, or historic importance (National Park Service 2020). It is important to note this inventory does not count the whole river itself, so one river can have multiple sections in the NRI. Florida has 63 segments from 46 rivers in the inventory as of 2017 and totals approximately 1,780 miles of river length (National Park Service excel file download). For perspective, that is only seven percent of the state's total 25,949 miles of river ways (National Park Service 2020). The EPCRA data was reported with the building addresses of users, so to validate the data using ArcMap, I first geocoded all the addresses to ensure all the locations were matched appropriately.

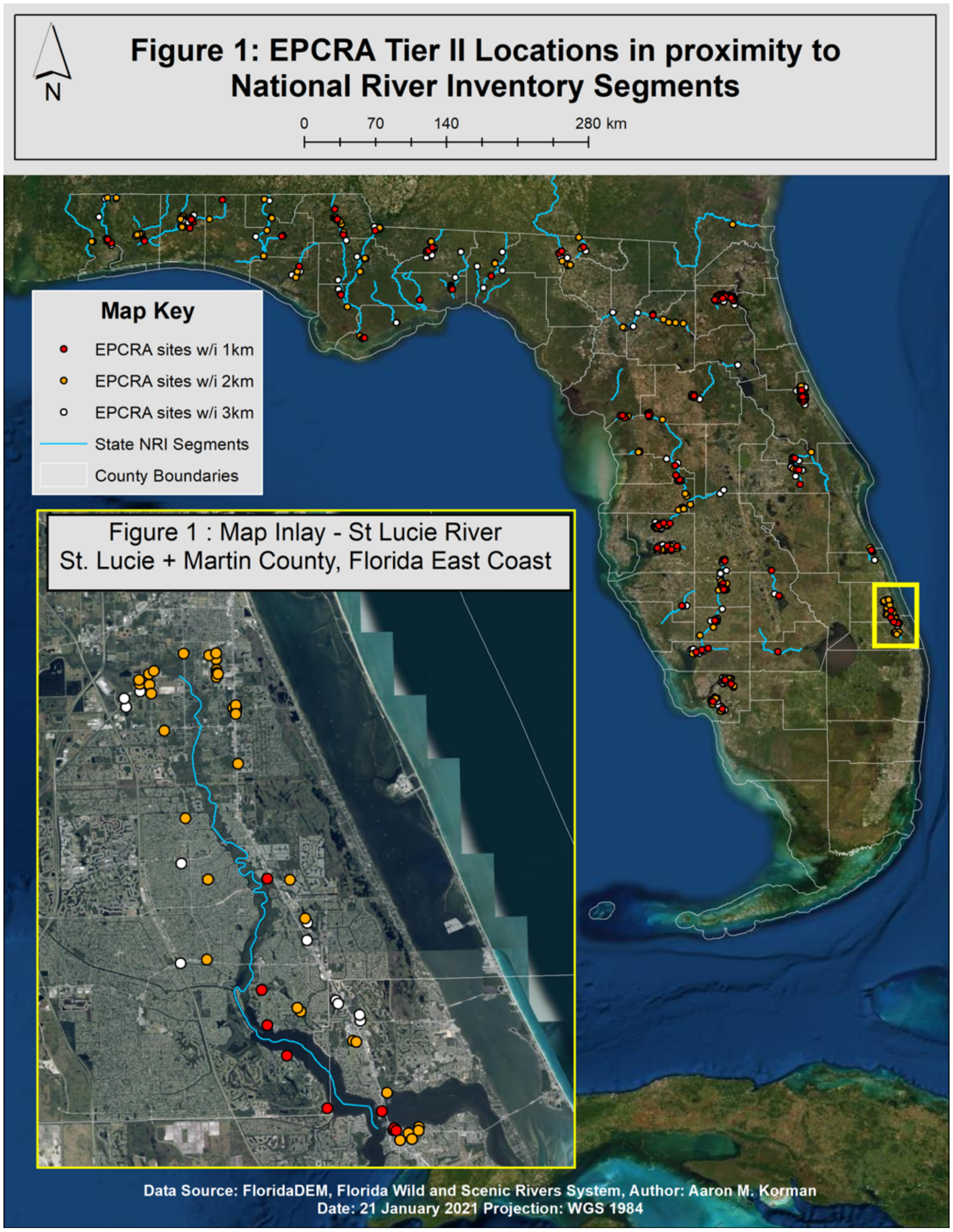

Figure 1 EPCRA Tier II Locations in proximity to NRI Segments

I then applied three different buffers of one, two, and three kilometers around each of the NRI segments to find only the Tier II sites that are within close proximity to the protected bodies of water. Multiple distances were chosen not only to analyze the number of chemicals and users, but also to look at different distances of movement for chemicals if released. Surface runoff can add multiple pollutants to the environment and nonpoint pollution is the leading contributor to water quality issues and pollution (Pearson 2018). Additionally, in studying runoff modeling from large storms the standards for proper data on water catchment use 1:00 and 2:00 travel times, associated with 1.5 and 2.0 km travel distance (Hallegeorgis 2018). To stay in line with these techniques I created the one, two, and three kilometer bands that could affect the NRI segments from potential pollution. For clarity, the buffer distances are not displayed, rather they are color coordinated by distance. The inlay in Figure 1 shows a micro view of these locations to the river segments on the St. Lucie River feeding into the IRL. This area was highlighted for low water quality and pollution issues and there are approximately 50 locations that reported using toxic chemicals above the EPCRA thresholds in this well studied area.

Within the 3 km buffer of NRI segments I found that 1,797 uses of chemicals were reported. These NRI segments are also connected to bodies of water and regions threatened by both SWI and septic pollution that would be further degraded should any of these chemicals be released. Highlighting specifically dangerous chemicals is important, such as pyrophoric chemicals that will react with oxygen by igniting or chemicals emit flammable gas when in contact with water. Looking at the use of those types of chemicals, as well as those that are either explosive or corrosive gives a good quantification of the potential risk of exposure. These specific chemicals are represented through their average daily max and maximum daily quantities. I chose to display two examples of highly used chemicals from the descriptors in the EPCRA data, and these are only four categories of the over twenty that are tracked for toxic materials. It is important to highlight that this is one use of these chemicals as reported by a single facility, there could be many more facilities that also report the chemicals in similar fashion. Even with such a small portion of the report highlighted, you can see that toxic use inappropriately close to environmental resources still accumulates to substantial risk from large amounts of toxic chemicals potentially released to injure humans and the environment.

Classification	NAICS Code	CAS Number	Chemical Name	Maximum Daily Qty (lbs)	Avg Daily Quantity (lbs)	EHS
Pyrophoric	332813	1310732	Sodium hydroxide (solution) [caustic soda]	107,455	107,455	No
Pyrophoric	221310	68476346	Diesel fuel #2	3,700	3,700	No
Simple_Asp	221112	7664417	Ammonia (anhydrous)	309,000	309,000	Yes
Simple_Asp	336414	7727379	Nitrogen	20,468	15,351	No
Corrosive	517311	7439921	Lead	218,774	218,774	No
Corrosive	221310	7664939	Sulfuric acid	107,100	85,704	Yes
Explosive	325312	16961834	Fluorosilicic acid (hydrofluorosilicic acid)	1,076,962	686,883	No
Explosive	424910	7664382	Phosphoric acid	291,575	176,542	Yes

Table 1 - Example Chemical Use within 3km of NRI Segments

It is important to show specific examples of these locations to provide perspective on their proximity to water sources and the potential ease with which spills, exposures, or releases could happen in acute events, such as increased rainfall over a month or season, or a large hurricane. For Table 1 specifically, the reporting threshold for CAS Number 7664417, Ammonia, which is an extremely hazardous substance, is 100 pounds, and this one reported use is 309,000 pounds daily. Going from a macro perspective of the state, I wanted to highlight a single example of the NRI segments and EPCRA user locations. The National River Inventory (NRI) states that we should “avoid or mitigate actions that would adversely affect NRI river segments” (National River Inventory 2018). In Saint Marks’s, development has not created an environment conducive to establishing this protection Figure 2 below is a map of Saint Marks, Florida, where multiple EPCRA uses were located within the established buffers and provide a good example of a lack of serious enforcement to protect these rivers. For Saint Marks, toxic chemicals such as chlorine, dielectric insulating oil, and sulfuric acid (two of which are EHSs) are used in quantities of 600, 499,999, and 94,626 on average in pounds per day. A spill of one day’s worth of operations in these facilities, much less than an event effecting all the facilities, could be devastating to the environment. The Wakulla River flows directly into the Gulf of Mexico and substances spilled there could affect much larger areas.

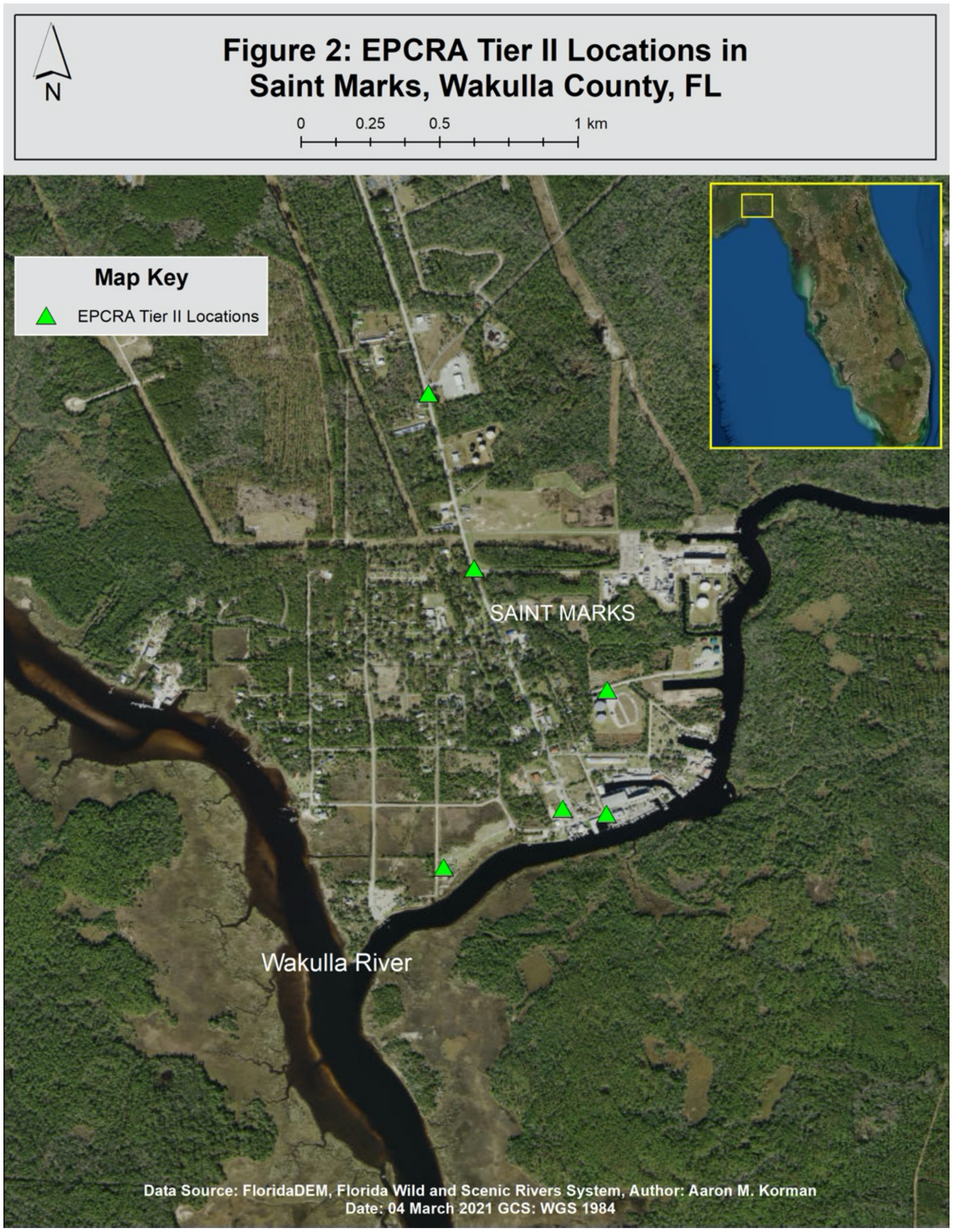

Figure 2 – ECPRA Tier II – Saint Marks, Wakulla County, FL

Similar analysis to the EPCRA sites applies to other sites where there were actual instances where spills occurred. CERCLA sites can be found within the state, and within Hillsborough County there is still a potential CERCLA site that hasn't been closed or completely cleaned up yet and is within the flood plain of the Hillsborough River. It is a good example of an area that should be hardened against potential exposures and is already having proven negative effects on people and the environment. The Normandy Park Apartments, EPA ID #FLD984229773, still have a status of “proposed” for inclusion to the EPA’s National Priorities List (NPL) (EPA 2020). The NPL is the nation’s most hazardous sites and inclusion is based on the results of the Hazard Ranking system. Within Florida there are 92 locations listed by the EPA that meet the risk standard. Prior to use for residential apartments, the site was home to The Gulf Coast Recycling (GCR) which smelted lead and recycled batteries on site. The company released lead and antimony to the environment, and they were responsible for building the apartment complex after the facility closure in 1963. It wasn’t until 1991 when residents complained about contamination, and the site is due for another five-year review in 2021 (EPA 2016). This site must be cleaned and closed appropriately to prevent further release and exposures.

Analyzing these EPCRA locations against well heads in the state provides a strong link between this described risk, the impacts of toxic materials, and the enforcement and potential problems with enforcing the SDWA. Impacts on wells used for drinking water is the most direct impact that toxics could have on us. If exposures or spills were to contaminate these wells at large scale the result would be disastrous. The Figure below shows the 4,104 EPCRA locations across the state that are located within 500 meters of a wellhead in the macro view and highlights an example within Siesta Keys, Sarasota in the micro view. The wellhead locations were downloaded from the FLDEP Geospatial Open Data.

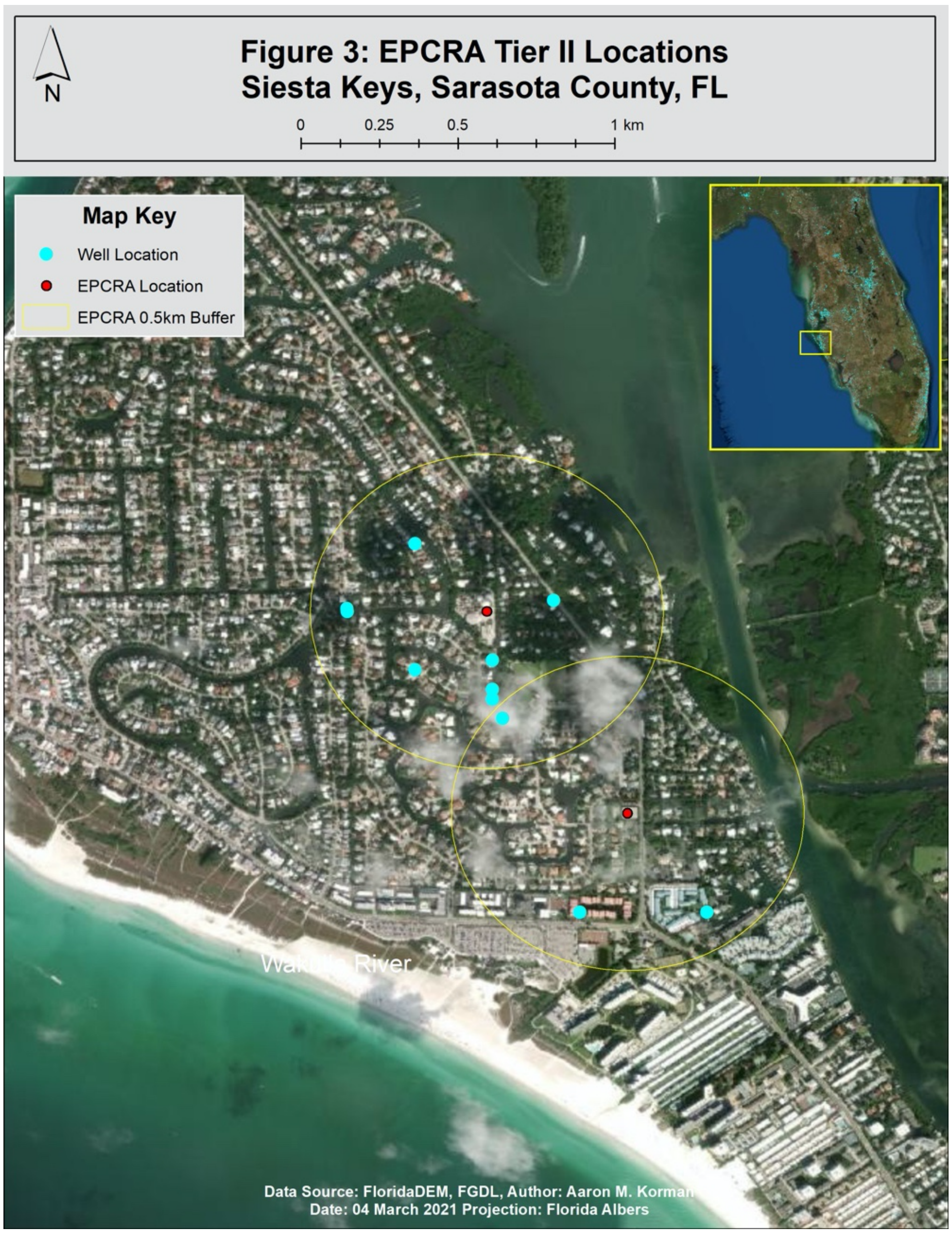

Figure 3 – EPCRA Tier II Example Siesta Keys, Sarasota County, FL

Using a simple example from Sarasota shows the complexity of the problem with well exposure on top of the NRI examples. In Figure 3 there are two

EPCRA locations that are well within 500 meters of nine wells with different used for commercial, water-based recreation, industrial, and public water supply, that if contaminated could directly impact multiple aspects of the lives of Siesta Key residents. These examples of proximity of toxic chemicals to locations that endanger both natural resources (NRI) and human health (wells) clearly show that changes need to be made.

To benefit from the protection outlined by environmentally focused regulations we must raise more attention and support to the problem, and we must work to better the process of enforcement. As a scientific community we must educate people to the significant problem and make our policy makers and leaders aware of the problem. This analysis highlights four areas to achieve the protection mandated 50 years ago. They are to re-frame the problem, reinforce existing policy tools, streamline information sharing to affect policy, and lastly use effective and timely means of litigation for enforcement of the SDWA. These efforts will provide synergistic benefits and help make necessary action possible.

To reframe the problem, we need to change how we consider the term enforcement and rethink the relationships between different programs, levels of government, and organizations. The term enforcement tends to carry a negative connotation. It brings views of strict rules, punishing actions, bad relationships, and an “us versus them” mentality. Not only is this a bad way to frame adherence to standards, it is inaccurate. Framing the goals of the SDWA from federal agencies and policies all the way to the glass of water you drink in the morning should be through teamwork, public health and shared goal making. The end state is safety of all, not just in Florida or only citizens of the United States, but to all those would travel or visit and would drink our water as well. This wider approach is important because of the strong base Florida has in tourism, which is a stream of people and money coming from all over the state and the world. All entities responsible for this enforcement must be viewed as teammates. We must bridge both the horizontal relationship between different agencies and vertical relationships between different echelons of government. There can be no sense of “them” because this problem impacts all at such a basic level of security and health. Detailed actions would be more in-person meetings where possible and building longevity within positions and agencies to build relationships. We can use these improved relationships to invigorate inspection standards that are supposed to be happening and put pressure on faster progress towards safety and health. This would include using relationships as leverage for federal level entities such as the EPA and the NPS to enforce these standards and inspections should the state not be able to. The concept of teamwork would create a symbiotic relationship rather than a competitive one.

At times pieces of the system tend to lose the human factor of the process. A PWS is an inanimate object on which data is collected but we must understand that these samples are taken by people, and the quality of inspections oftentimes depend on the demeanor and personal tact of the inspector and inspected. The focus needs to be on the quality of water, not the way a PWS looks on paper or potential funds allocated. Both sides are a team that must work together, not a large federal agency stomping down on a small PWS only attempting to serve adequate water. The focus needs to highlight assistance towards a common goal, rather than the punishment for failure to meet a standard while accountability for water quality is established. The sociological and interpersonal aspect of those processes is often understated for its potential impact on results. The people in these positions matter greatly and u utilizing their strengths and weaknesses can be very beneficial. It's about managing their talents and shortfalls to reach the goal as a team.

The existing tools within the SDWA are helpful but need improvement. Although the SDWA requires that every system submit consumer confidence reports (CCRs) every year, the information doesn't always paint the appropriate picture on either water quality or system compliance. The CCRs are a part of the public notification rule, and violations that don't directly impact human health may only need be reported once within a year. Information of sampling violations is infrequent and doesn't even reach many of the end users because the rule doesn't apply to private wells, and many people live in hotels, condominiums, apartments, townhomes. Since the CCRs only go to those who interact with the water system or pay the water bill, people won't be directly informed of the problem at large or local scales based on the current system (EPA 2016, CDC 2015). Additionally, from 1997-2003 Congress had a budget of $100 million each year to support states' enforcement of the public water supervision system. This is nowhere near the appropriate amount needed to help the water systems enforce the SDWA standards (Tiemann 2017). Many similar issues are found in multiple water systems and require updated technology or increased efforts to fix. This quickly adds up to high dollar amounts when considering equipment, labor, and maintenance costs. With Florida's 5,119 water systems active in 2018, if allocated $100 million dollars of support for a year only given to half of the systems, they would only receive approximately $39,000 USD to bring them into compliance. Additionally, there are 49 other states vying for the same allocation of money. We need to increase this external funding support to the states, but that needs to be augmented from building efficiencies within the states through prioritization and house cleaning efforts. The EPA offers programs such as technical assistance, grant assistance for small communities, and emergency assistance in the case of dire needs. These programs need to be expanded to apply also to the larger water systems and they need to receive much more investment. Likewise, improvement in enforcement and monetary support for EPCRA is needed as well. The perspective releases discussed in this project can be avoided through rigorous standards for storing, labeling, and use of toxic chemicals. These standards then must be inspected and enforced on a regular basis, and at times education is needed to ensure a common understanding of the standards. The number of chemicals and users described in the dataset provide good scale for how many inspectors, classes, inspections, and money is needed to appropriately enforce both EPCRA and the SDWA. We must use this information to go out and harden these at-risk locations to provide for better and more resilient coastal regions. The Florida League of Cities, advocating for hundreds of cities across the state, is uniting a movement to put more focus on Florida’s drinking water problems in state and national policy. Their movement includes requests for more frequent inspections, monetary support for development, and they are proposing through SB1720 and HB1427 the creation of the Florida Safe Drinking Water Act (Cassels 2020, FL League of Cities 2020). States have primacy of enforcing the Safe Drinking Water Act, the state government needs to provide more structured oversight and funding to the system. I recommend establishing a system of emergency support for every single water source and publish capacity studies for each water system in the event of a natural disaster. Much literature explains the vulnerability of the water sources for much of the state and the need for redundancy is clear. The 2008 Action Plan states “Identify and quantify the potential effects of differing climate change scenarios on the vulnerabilities and reliability of existing water supplies with emphasis on source water availability and quality.” (Governor’s Action Team 2015). When written we already knew the water sources were vulnerable, and while the identification and quantification is needed, it's not enough. If one water system or source is contaminated, flooded, or collapses how do we react? I suggest that a multi-level network is built based on the following five criteria: proximity to the problem, size relative to the contaminated source, capacity of the water source (for short or long duration), infrastructure available to transfer safe water and potential cost of the infrastructure needed. This level of detail is appropriate to mandate and enforce. Understanding the problem completely isn't always needed for action to start and following the precautionary principle will provide many benefits.

Streamlining the information might be one of the easiest things we can do and get the most reward for our efforts. We live in the technology and information era. Never has the country and its people been more connected to widespread and fast information. Not taking advantage of this would be a mistake towards progress to increased public health. Efforts such as using social media, websites that can portray the data to tell a story, or similar platforms will be key in highlighting the problem. Applications for phones, laptops, and tablets are increasing in use compared to magazines or newspapers. With the click of a button millions of people can be reached in an instant, that power cannot be understated although it has become common. Appropriate use of popular figures to bring attention to the problem would be beneficial as well. To affect policy, you need enough public support to get momentum on the issues and show policy-makers problems need to be solved. Using technology to bring people together (digital cooperation can be significant, as we have seen during post COVID-19 lifestyles) is paramount in solving today's problems and community as well as togetherness are important. The information is readily available but needs context and illumination to be understood at scale and by the right audience. The county of Palm Beach provides a good example. The SDWA's enforcement is handled by the Florida Environmental Protection Agency and the Florida Department of Health. Specific to Palm Beach County, the regulation of the PWSs is handled by the Florida Department of Health in Palm Beach County (FDOH-PBC 2019). It is one of seven counties in the state where the DOH is responsible for “oversight of construction and operation of all public water systems.” (FDOH 2019). Within Palm Beach Country the three mentioned water systems with years of violations provide water to one fifth of the county population’s drinking water. It is irresponsible and misleading for the agency responsible for this oversight not to highlight this to Florida citizens. The FDOH-PBC’s website states that “The safety of our drinking water supply is critical to the health of residents and visitors of Palm Beach County” (FDOH 2019) but only offers a short history on the SDWA and no specific information as to their ability to provide that safety. The data presented on these facilities was provided at the federal level, other reports such as the Annual Report on Violations of the U.S. and Florida Safe Drinking Water Acts in the State of Florida are provided at the state level by the FLDEP, but FDOH-PBC provides no such information. The link for cooperative and productive enforcement of the SDWA appears to be broken at the local level. Local governments are important for being closer to those governed and higher ability to work together, and much discussion highlights the benefit of increased focus at that level (Lobado 2016). In similar fashion to the DOH, the FLDEP Standards and Facts Drinking Water states that “the department’s efforts are reflected in the very high compliance rates of water systems throughout Florida" (FDEP 2016), but based on the federal data showing the significant violations, this does not seem to be the case. Furthermore, the SDWA also mandates protection of water sources in current use, but also to monitor and prepare those that might be needed in the future (EPA SDWA 2020).

Rather than waiting for the tediously slow and politically dependent bureaucracy to create policy and regulations, many people are turning to litigation and using the court systems to force actions or support causes. A good example of this is the continuing Juliana case, in which young people are suing on behalf of their rights to a future that is bright and healthy without anthropogenic climate change side effects. The SDWA is a federal mandate giving powers to the EPA to set and enforce standards in our drinking water, that authority is then promulgated down to manageable and effective levels. Good in concept has been bad in execution. Communities can look to the courts if they aren't receiving information about their water, or safe drinking water at all. Communities at large serviced by large PWSs could easily prove that they have both standing and have received harm by drinking water that is not to standard. Violations in the SDWA are scientifically proven to cause undue harm and is the reason we regulate it all and violation of it proves harm. It follows that the direct link from the PWS to the end users provides their standing in the harm caused. This is a much more direct case from the mentioned climate change cases, and I think it would be beneficial in bringing much needed attention and tangible progress to the efforts in improving drinking water across not only the state but the country. Additionally, this can be used at multiple levels of courts from local to the Supreme Court. Not only is there space for appeal, but every entity in the chain from end user to the federal government has a responsibility to uphold the national standards and laws. The execution of federal mandates is not meeting standards. This project highlights the necessity for all to increase focus on the prevention of spills and protecting our natural resources and environments rather than focus on after a release occurs. Increased efforts into controlling the handling, storage, tracking, inspections, and enforcement of all these portions of EPCRA will decrease the effects of potential spills. Increasing publication of these efforts, highlighting the real and potential danger of the situation, will also motivate more people to act and help.

This project highlights effects that are already occurring to Florida's drinking water and nearshore marine environments, but also accents the looming threat that acute events could have with respect to quickly degrading the environment via toxic substance interaction or release. In contrast to these direct impacts, many indirect impacts are often understudied and underappreciated. To understand more impacts that toxic substances have on wider scales the next section looks at quantitative data to understand the external impacts on the economic landscape in the state. Whether through pollution of septic tanks or other chemicals present in marine environments, it may be that the hidden cost of these degradations can be found in the fluctuating prices of houses. A well-known and significant problem occurring in Florida is the HABs that are ravaging the coastline, and their direct impacts which include degrading water quality and a dropping tourism industry. While their direct impacts are clear, these HABs also have many indirect impacts that are not understood. The next section of this paper will be an attempt to quantify the external cost of these HABs in the form of changing housing prices. Multiple studies do cover the decision-making factors of living and buying property in sensitive coastal environments. In 2018 adaptation was viewed through the lens of wielding property insurance and financing programs as a tool for improving coastal regions (Craig 2018). More specific to property value, another study analyzed what they termed climate change bubbles of real estate networks in coastal environments (Nolon 2015). Both found decision making and property values have intricate relationships that are not fully understood. Better understanding of these relationships will give much better insight into the significance of the HABs and their impacts on Florida and its economy.

SECTION 3 INDIRECT THREATS TO FLORIDA'S FUTURE

This section will focus on economic impacts from a toxic algal species that has ravished the coastal environment in Florida and has impacts beyond the degradation of its immediate ecosystem. Additional to the problems of water quality, pollution contributes to a very large economic impact the state is experiencing. Specifically, it is proven that N and P pollution can degrade marine waters and directly enable the formation of HABs in a portion of the St. Lucie estuary that bridges the borders of St. Lucie and Martin counties (Lapointe 2012/2017). These HABs degrade the aesthetics of the water and have had drastic impacts on economic profit due to decreases in tourism rates. Additionally, algae has been found in humans via blood testing after conducting recreational water activities (Backer 2008). These economic losses aren't just to the tourism industry as degrading water quality also leads to fish and dolphin kills which affect other industries such as fishing and stress the human health support network. These direct impacts are relatively clear to understand, unlike many of the indirect or hidden externalities that go along with degrading water quality and the presence of HABs. A broader perspective on the impacts of toxic substances and their effects must be taken for a wholistic understanding of the problems facing Florida's future. More people are moving to the state to avoid northern winters or stay permanently, increasing the number of people entering and exiting the housing market at a rate of 17.6% population growth from 2000 to 2010 (Noss 2011). It is well established, from the hedonic approach to property valuation, that aesthetic characteristics of these properties affect the price as they change hands, for example square footage or number of bathrooms (Bin 2017). I want to explore the question: is the value of a parcel affected by these HABs? If so, to what extent? To answer these questions, I intend to quantify the relationship between the presence of toxic algae HABs and housing market values via estimating a relationship between concentrations of karenia brevis (cells/L) and parcel sale prices in five coastal counties.

Much effort has been put into the observation, analysis, and prediction of toxic algae in Florida since the 1950's. Algae are small unicellular phytoplankton that are found in both toxic and non-toxic species throughout the world (Anderson 2005). When algae accumulate to concentrations over 100,000 cells per liter (many concentrations grow to the millions) and large generally contiguous areas known as blooms, they can have devastating direct effects such as the depletion of oxygen availability and killing organisms in the marine environment (FFWCC 2020). Algae's toxicity is manifested by creating cyanotoxins that are responsible for directly sickening or killing animals through secretion of the cyanotoxin itself, or when the algae itself is consumed and the cyanotoxins bioaccumulate in the food chains affecting even large mammals (Anderson 2005). These large areas of toxic and damaging algae blooms are commonly referred to as Harmful Algae Blooms (HABs). National attention has been on these HABs for decades, and in 1998 the Harmful Algal Blooms and Hypoxia Control Act was passed and has since been amended twice, as recently as 2014 (Ecohab). There are many different species referred to by the term HAB, but this focuses on the HABs that are created by a specific dinoflagellate (single celled plankton) named Karenia Brevis (K.Brev). Although HAB is a more inclusive term, I will use it to specify only K.Brev blooms moving forward, since these are both toxic and the most common found in Florida (FFWCC). These K.brev HABs, commonly known as ‘red rides’ due to the distortion of watercolor they create, are a specific type of harmful algal bloom (HAB) that damage local ecosystems through their pervasiveness and toxicity. They are thought to bloom off coast and then be transported shoreward by prevailing winds and wave conditions (Brand 2007).

HABs have a multitude of negative effects on the environment and there is increasing literature that their continued increase is due to nutrient loading from anthropogenic sources and their ecosystem level effects could be more pervasive than we currently understand (HARNESS 2005). Their impacts have been quantified in mammal mortality events and recreational tourism loss, which will be expanded on in following sections of this paper (ECOHAB). Increasingly prevalent in the fall months due to higher nutrient availability, and considerably more intense in the Tampa and Ft. Myers areas of Florida (Hillsborough and Lee counties respectively). Studies conclude that HABs have increased substantially over the past half century (Brand 2007). Linking these HABs to anthropogenic processes, a study found that submarine groundwater discharge (SGD) derived nutrients had a role in the 2005 significant HAB off central Florida’s west coast and may trigger or sustain HABs more widely (Chuanmin 2006). Another two-year study on the eastern coast of Florida in the IRL, found that excess nutrients (especially N) stemming from septic sewage contamination was the primary driver in the HABs observed over the study period of 2011-2012 (Lapointe 2015). The IRL is a water complex that begins as far north as Volusia County, and terminates in Palm Beach County on Florida's eastern coast. These studies clearly establish a broad link between HABs and anthropogenic causes. This project attempts to build on these findings and improve understanding of HAB's effect on human decision making in the housing market.

HABs have significant impacts on many different levels of species ranging from similar unicellular organisms to fish, dolphins, and even humans. Species of many kinds can be directly poisoned by the cyanotoxins in HABs, but large animal mortality events have been linked to the bioaccumulation of these toxins. A study in Sarasota Bay found that certain species such as pinfish are a viable vector for bioaccumulation and transfer of brevetoxins and are prey fish for bottle nose dolphins (Fire 2008). Further analysis on fish communities from 1980-2009 shows that HABs increased mortality rates and affected predation and competition structures in certain species of fish (Di Leone 2019). A 2009 study found that HABs caused a distinct decrease in fish abundance, fish community structure and increased fish kill levels in SW Florida (Gannon 2009). Not only were brevetoxins established within prey fish of bottlenose dolphins they were also linked to three mortality events that occurred in between 1999 and 2000

(Twiner 2012). The human health impacts are extremely important and a key piece to the study and management of HABs. The FFWCC bases its categorical values from HABs on health and environmental impacts with effects including respiratory irritation, fish kills, and water discoloration (FFWCC). These negative impacts on fish, dolphins, and water are the specific examples of the detrimental effects HABs can have on tourism and local animal ecosystems. These direct impacts have drawn much attention both in academic research and in environmental monitoring and protection.

Due to their significant impact much work has been done in the past 60 years in attempt to improve methods to identify, mitigate, and predict HAB's effect throughout Florida. There are many different organizations such as the Florida Fish and Wildlife Conservation Commission (FFWCC), the Ecology and Oceanography of HABs (ECOHAB) from the National Centers for Coastal Ocean Science, and the Cyanobacteria Assessment Network (CyAN) hard at work. The FFWCC has consistently been monitoring since 1954, with initial motivation to monitor HABs linked to copper sulfate spraying with pesticides in the 1950's and extreme animal mortality events in the late 1990's (FFWCC). In 1956 the state started a Better Fruit Program, using copper to help leaves decrease grease build ups and build nutrients only to find later a significant toxicity problem and potential damaging effects to the environment (Driscoll 2004). Later, the mortality events in the bottlenose dolphin population of Florida's panhandle again drove motivation for HAB attention since there was a potential link between the time frames of the mortality events and years where there were higher prevalence of HABs (Twiner 2012).

HABs will continue to be a problem and Increasing rates of population growth and pollution are not going to improve the situation. Techniques based in remote sensing by using platforms such as the Sea-Viewing Field-of-View Sensor (SeaWiFS) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellites is popular due to the ability to cover large areas at a consistent time frame. Additionally, remote sensed data is easier to compile at large scales instead of the slow field sampling and microscopy that is usually used (Klemas 2012). Although spatial coverage is adequate, spatial resolution is problematic and this data cannot be used alone to determine HAB structure or to find or establish correlation with other variables (Olascoaga 2008). K.Brevis does have unique reflectance, chlorophyl-a content, and backscattering characteristics that have made it possible for a 70-80% correct identification rate when corrected using a mixed empirical method with a bio-optical method based on four years of MODIS data, but it doesn’t completely solve the problem (Millie 1997, Carvalho 2010). Although data are consistently collected to predict HABs and increase response techniques and timelines, through analysis of the literature on the valuation of these remote sensing techniques the consensus is that they alone cannot effectively distinguish HABs of K.brevis from other potential causes or sources (Tomlinson 2004, Cannizaro 2009, Chuanmin 2008, Cannizaro 2008). This project’s focus necessitates a different data source from these remote sensing techniques described due to the spatial resolution required for analysis in conjunction with parcel sales data. However, the resulting analysis from this project could be an area of collaboration. Better technology will refine remote sensing techniques in the future, thus improving the ability to anticipate and forecast HABs. Expanded in section three, this could provide resiliency in housing markets through a better ability to forecast HABs and in turn predict changes in other effects such as tourism rates or house value. To conduct this project, I used data gathered from the ground from the FFWCC.

The most effective technique found to truth remotely sensed data was to use ground measurements that sampled the water to microscopically identify the algal species and concentrations. Since remote sensing techniques continue to improve and seem to be building more and more potential for use, I will use the same data used to verify remote sensing techniques and grade their accuracy. The most appropriate dataset is the Fish and Wildlife Research Institute (FWRI's) historical data base. This data base is coordinated and provided by the FWRI, which is a part of the FFWCC, and contains geolocated samples and dates along with abundance of karenia brevis (cells/L) found in the sample from 19 August 1953 – current (FWRI). It is important to note, that along with previously discussed sampling bias within the data, it is not a daily sample. They are records when sampling was conducted, from multiple institutes ranging from formal researchers to weekend volunteers and contains the sample abundance from when they were taken. Moving forward this will be referenced as HAB Data.

It is difficult to connect this historical data to a true sense of HABs increasing in Florida over the past decades due to inconsistent sampling methods and distribution, and how much of the attention given to HABs was reactionary or tied to specific events (FFWCC). A study in 2007 compared natural background levels of K.Brev of approximately 103 cells/L and found that there was nearly a 13-14 fold increase in HAB occurrences and severity (Brand 2007). To validate his findings through my own studies the maximum value found in the two years considered in this project was 186,266,667 cells/L (FFWCC). Additionally, they hypothesize that increased human activity on the coasts has provided nutrient concentrations high enough to support the drastically increased HAB numbers found, and that they occur nearshore in much higher rates than offshore and will likely continue to do increase (Brand 2007). These nutrients were previously linked to anthropogenic sources such as septic pollution. It is important to highlight this link between HAB occurrence and human activity since the connections between HABs and climate change are weak. This is because HABs also occur pristine waters that are uninfluenced by anthropogenic actions (Brand 2007). Although this dataset can't statistically establish that HABs are increasing, there is much literature saying that HAB severity and frequency is and will continue to increase in the future (Mishra 2019, Van Dolah 2000, Brand 2007). This data set can be effectively used in correlation with other variables to understand relationships therein. Prior to use in comparison to parcel sales value this data had to be treated and altered into a useful format.

The data was treated to the target time frame of 2018-2019, 2020 data was not used because of the tempestuous times in response to the COVID-19 pandemic and the great impact that it had on the economy. Samples were removed that were at different depths but same location and limited that location to its surface value. Validation for this was that the surface area's concentration is most applicable and most important to those considering water quality and housing purchases. Even higher concentrations at lower depths, potentially unseen or unnoticed, might not affect decision making in the same manner. This technique was consistent with studies conducted in Lee and Martin Counties by Florida Realtors, a trade association founded on fairness and professionalism in the real estate business. In their study, water quality measures used such as chlorophyl levels were not based in inherent or potential harm to an area, but degradation to the visible characteristics which were thought to affect homebuying decisions greater (Florida Realtors 2021). Where there were multiple samples on the same day at same location the maximum value was taken for the same reason as the depth consideration. This enabled a single concentration value of K.Brev for each sample location given by longitude and latitude from which a two dimensional surface could be created. Finally, removal of any samples with no identified depth or data for k.brev or duplicates rendered the final data base csv for further analysis. This resulted in two years' worth of point data, approximately 983,202 samples of k.brev throughout the entire state. The data was disaggregated and organized into monthly temporal scale. This was done to match parcel sales data records, which provide the year and month a sale took place and will be expanded on later in this section. The treated sample data was then brought into ArcMap, from the ESRI ArcGIS application suite. The monthly data segments were transferred from the csv feature class into shapefiles to interpolate them appropriately. Interpolation was conducted using the Spatial Analyst Toolbox through inverse distance weighted analysis of the monthly HAB shapefiles. This resulted in twenty-four surfaces, each a continuous variable raster, one for each month, that accounted for the variation of all the HAB samples taken in that month and year. Lastly, due to the parcels being polygons located on the land, all land had to be removed from these monthly raster surfaces. A border of the Florida shoreline provided by the FFWCC's Wildlife Research Institute was used as a land mask and erased from each of the surfaces, leaving each surface with HAB values that accounted for all sample values from around the entire state for a month. These twenty-four continuous surfaces are the final HAB data treatment used in the project. Further analysis will be provided after the parcel data is introduced.

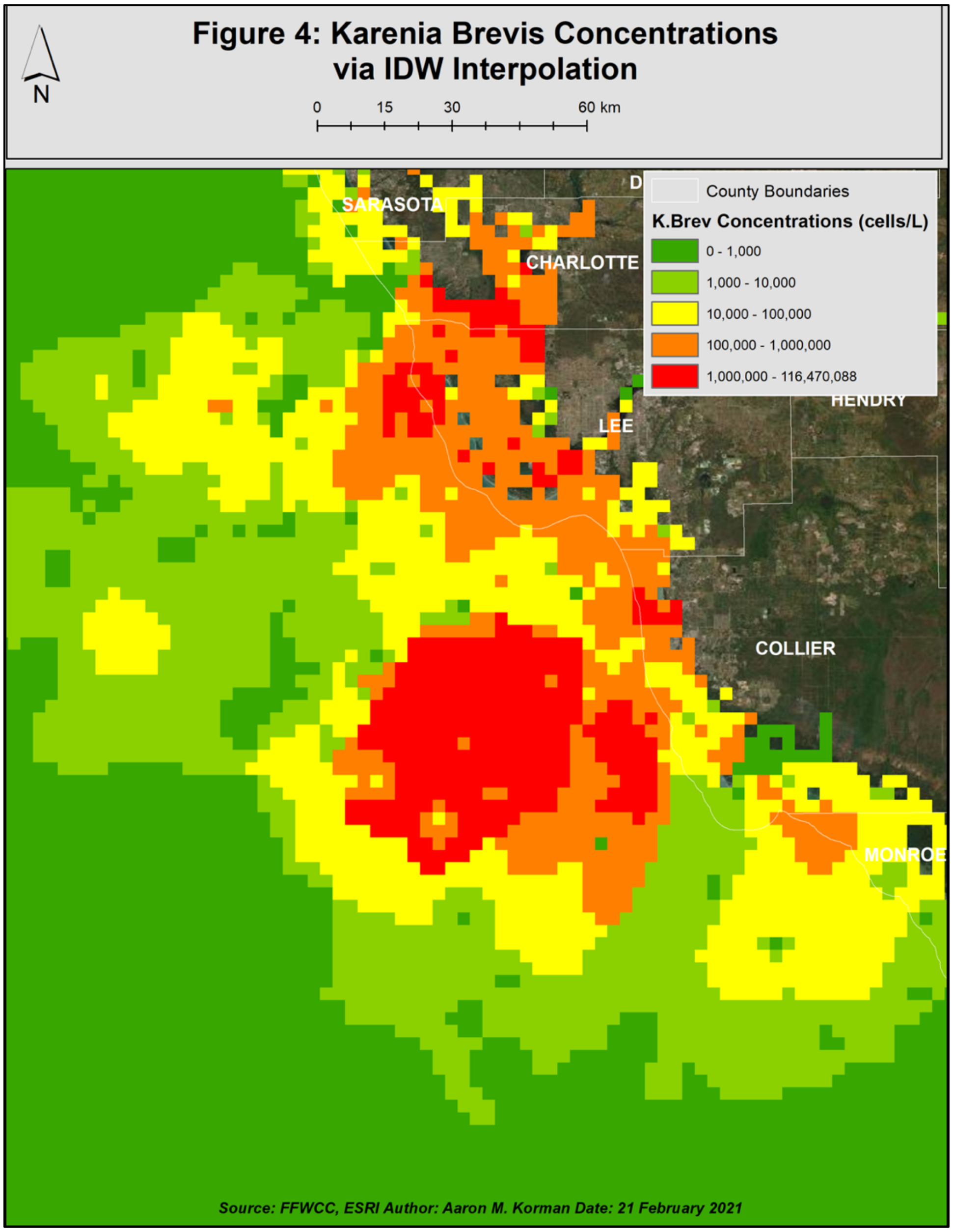

Figure 4 Karenia Brevis Concentrations via IDW Interpolation – 2019 Example

The value of a property is inherently based on the amenities provided by it and its community. Much research is founded in understanding this relationship and attempting to understand human decision making and appropriately quantifying property value. The hedonic price model was established decades ago and provides a framework to understand the interaction between consumer and producer based on the characteristics of a property considered (Rosen 1974). Stark differences were found in analyzing data provided from different counties and from the state to county level. For example, some counties do not record data on bedrooms, where some have data on secondary half bathrooms and fireplaces. For continuity across the counties, we kept data about the spatial extent of the parcel in land and useable area for living, and the number of bedrooms, bathrooms. Other aspects of a parcel account into its valuation beyond just the structure or land characteristics. These include both the community and services provided by it, therefore distance from common services such as police stations, schools, and fire stations were included in the data set.

Much work has been done to understand the environmental characteristics such as trees, air quality, and water quality and how they affect property value. Similar to the discussion on services the community where a parcel in effects it's value also. Looking at the surrounding environment is crucial when considering parcel value. Toxic plant establishment was found to decreased house value by 11 percent within 0.5 miles of the plant across the country, and air quality improvement in the 1970's resulting from the Clean Air Act had a value of $45 Billion in increased property value (Currie 2015, Chay 2004). Specific to water as an amenity, it was found in Italy that water quality increased housing prices, and in North Dakota seasonal flooding risk from the Red River was found in a discounted price value of 13% the property value

(Bonetti 2016, Zhang 2018). To appropriately control for these physical characteristics, common ones in consideration were included as independent variables later in the project.

Many studies have quantified environmental influence on the local economy specific to Florida. It was shown that increased canopy cover by one percent from urban trees increased house values by approximately $9,000 (Donovan 2019). The trees that were analyzed were studied within a distance of 152 meters with similar studies looking at up to one square kilometer, in a similar fashion this study analyzes a smallest buffer distance of 1 kilometer to capture immediate effects and those houses sold on the water. Also, high coastal flooding risk was clearly capitalized into property values after Hurricane Sandy in 2012 (Chandra 2019). Furthermore, water quality has a large effect on housing prices in Martin County, FL where a 1% point increase in water quality was associated with a mean property value increase of $2,614 (Bin 2017). Only one attempt was found to specifically identify and quantify the relationship between HABs and housing prices. Earlier this year Bechard 2020 found that housing prices decreased during blooming months using transaction data from Zillow and focusing on the SW Florida (Bechard 2020). Finding the wider effects that HABs have on the housing market and implications of their distribution is critically important and understudied. I explored HAB impacts on Florida counties from both sides of the state with data published by the Florida Department of Revenue and County Appraisal offices to increase our understanding of their impacts.

The HAB data provided by the FWRI will be used in conjunction with sales data provided by multiple sources from the state and county levels in Florida. Moving forward, this will be referenced as Parcel Data. Due to differing consolidation standards and techniques at different governmental levels, the data was consolidated from both the state Department of Revenue (FLDOR), and from the specified county appraiser offices. To appropriately treat the data, I started with the parcel as the base unit for analysis. The parcels were tracked at both the county and state level as discussed and first requested were the ArcMap shapefiles, Sales Data Files (SDF), and Names Address Legal (NAL) that provided the basis for the parcel data from the FLDOR. This enabled a geographic basis for the parcels and ability to connect them to the HAB surfaces already discussed and provided the appropriate monthly sale data for accurate temporal resolution. Then the characteristics of the parcels, data consolidated at the county appraiser offices, were joined to the parcel files from the state. This proved tedious due to the differences in storage techniques, downloading availability, and data format across the counties.

First, from the FLDOR SDF, parcels were chosen that were sold in the target years of 2018 and 2019. Only what the state considers single family residential parcels were used, using the land use code of 01 for state and county data. Additionally, any sales from previous calendar years or with no sale value were removed. Parcel sold in 2018 and 2019 were considered, and random sales from across multiple counties were consolidated into a single data set.

Incorporating sales from multiple coastal counties, all of which experienced different levels of exposure to the HABs over each of the two years considered. I applied the sales approach across five counties which gave us a final list of sales within the two years. Sales were taken from Hillsborough, Sarasota, Lee, St. Lucie, and Martin Counties. Coastal counties within the west central Florida coast, and opposite on the east coast were considered due to the difference in HAB exposures throughout the years. This process was conducted using ArcMap by joining the GIS shapefiles to the tables of sales data and county characteristic data. Using the keeping only matching records option throughout the process enabled consistency in the parcels selected and a consolidated list as well as shapefile of the sales across multiple counties.

Multiple buffer rings were used to create zones of 1, 5, 10 and 20 kilometers distance around each of the parcels sold. Reasons for choosing rings of these distances vary. Starting at the biggest rings of 20 kilometers, the water quality of the ocean water at the beach is a unique characteristic for a parcel. Similar to the distances highlighted to communal services, many people will buy a house within a given distance or time frame to the beach. To capture those commuters to the beach where the quality of the water would play a role in their decision making but also not extend values that are too far offshore, the larger 20 and 10 kilometer rings were established. The two smaller rings were meant to find the HAB values and data that were more immediate to parcels closer to, or directly on, the water and have small spatial resolution immediately around the parcels. I used these buffer rings, overlapping with the continuous surface rasters to provided multiple measures of HAB concentrations at different distances from each parcel. This enabled measurements of HAB presence in relationship to a parcel sold, and the data resulting from conducting zonal statistics from the ArcMap Spatial Analyst's ToolBox was added to the data file and connected the parcel data to the HAB data. Choosing parcels outside of the distance buffers across multiple counties would be too tedious and introduce selection bias into the data set. Due to the potential proximity of sales and their respective overlapping buffers, a supplemental iteration of the toolbox, 'Zonal Statistics 2', had to be applied to the data to ensure that the tool could process zonal statistics of overlapping polygons.

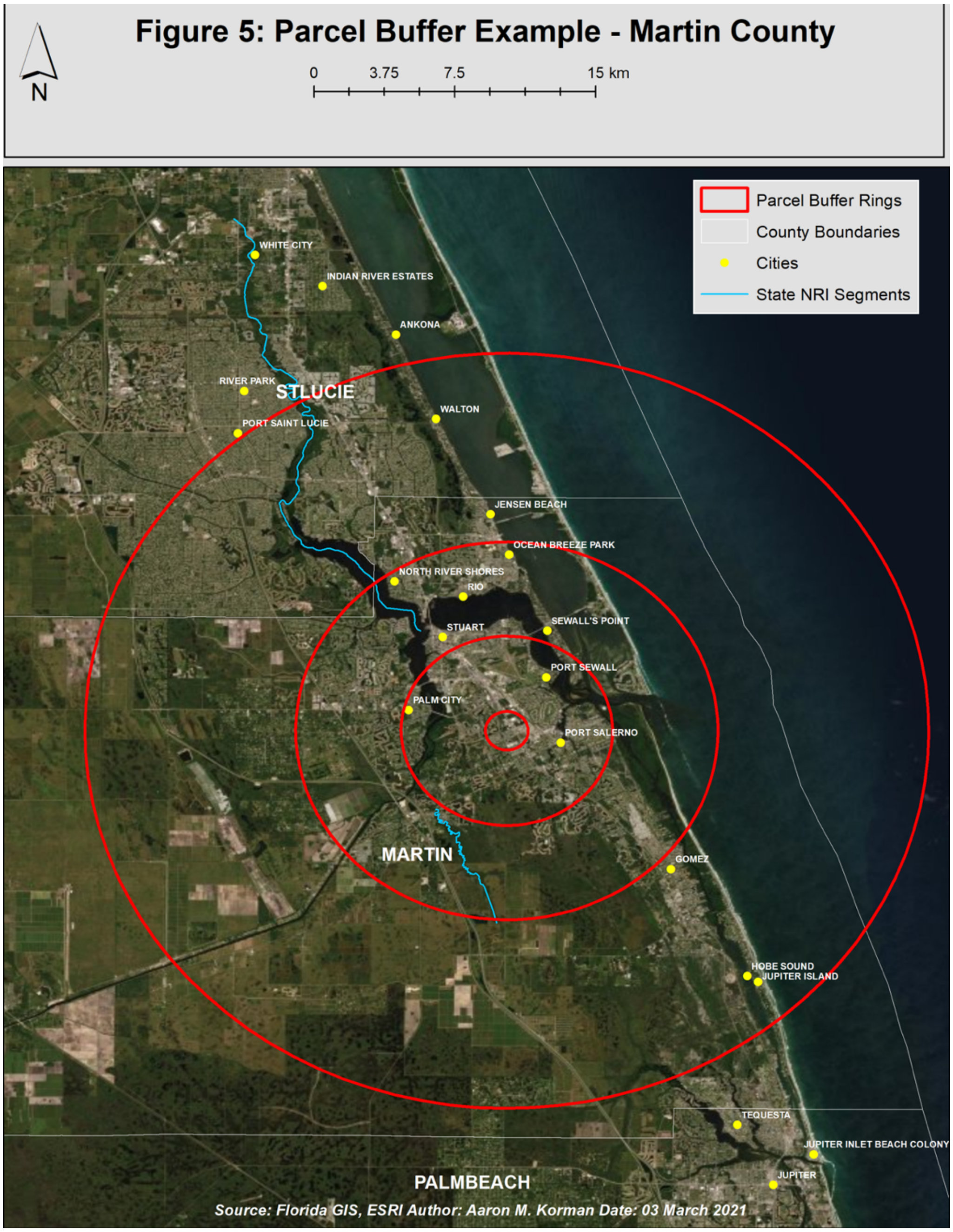

Figure 5 Parcel Buffer Example – Martin County

Additionally, much of the effort and decision-making considerations in purchasing a house is done weeks and months prior to a sale occurring. Conditions before the date of the sale are important to the analysis of what variables are inherently important in a house's valuation. In order to capture the decision making process in purchasing homes, and likely the timeframe when the HAB presence or severity could impact a decision to buy or not, lagged values of the HAB data were used. For each sale, the matching surfaces were considered when consolidating zonal statistics for the month of sale (current), the month previous to the sale (lag 1), and the second previous month to the sale (lag 2). This study was conducted on a smaller temporal scale then the study referenced, as their data was included to the previous month, but the previous year as well (Florida Realtors 2021). Once the HAB data was added, this was considered the final flat data file that was presented to an automated model chooser to estimate a relationship between the independent and dependent variables.

Surveys of valuation attempts for properties show over 400 statistically significant parameters and multiple levels of application, limitations of time and data similarity across multiple counties decreased those used in this study (Metzner 2017). Broadly, they are broadly grouped into details from the SDF, the NAL (both from the FLDOR), the county level appraisal offices provided the number of bedrooms and bathrooms, distance analysis for HAB concentrations, and finally distance analysis for nearness to communal services. The data set contained 6,195 sales.

Variable	Coefficient	Std Error	t-value	t-prob	Part. R^2
GRP_NO	7802.51	1231	6.34	0.0000	0.0071
NBRHD_CD	0.000306507	9.425E-5	3.23	0.0012	0.0019
QUAL_CD	-971.192	74.03	-13.1	0.0000	0.0296
SALE_YR	18.2884	3.436	5.32	0.0000	0.0050
JV	1.07245	0.02814	38.1	0.0000	0.2049
TV_SD	0.186440	0.02884	6.47	0.0000	0.0074
TOT_LVG_AR	-18.8648	2.154	-8.76	0.0026	0.0134
NO_BULDNG	-124208	5856	-21.2	0.0000	0.0739
BATHS	29542.8	2164	13.7	0.0000	0.0320
BREVSUM5KMC	0.00260202	0.0008933	2.91	0.0036	0.0015
BREVMAX10KMC	0.0251305	0.005380	4.67	0.0000	0.0039
BREVRANGE10KMC	-0.0252357	0.005387	-4.68	0.0000	0.0039
DISTSCHOOL(M)	5.86296	1.264	4.64	0.0000	0.0038
DISTPOLICE(M)	-2.06927	0.6869	-3.01	0.0026	0.0016

Table 2 Oxymetrics Output – Model

Figure 4 displays the final formula that Oxymetrics produced via an ordinary lease squares analysis. Additionally, Figure 5 below is a truncated list of the outputs identified as impulses for sales value, or values that were higher or lower outliers than expected by the established model, a full list is provided in the Appendix 1.

I:15	-402674	1.162e_05	-3.47	0.0005	0.0021
I:16	-376941	1.162e+05	-3.24	0.0012	0.0019
I:103	-567237	1.161e+05	-4.88	0.0000	0.0042
I:129	4.63562e+06	1.161e+05	39.9	0.0000	0.2204
I:131	4.63926e+06	1.161e+05	40.0	0.0000	0.2207
I:359	4.60986e+06	1.161e+05	39.7	0.0000	0.2185
I:391	4.63526e+06	1.161e+05	39.9	0.0000	0.2203
I:451	1.13968e+06	1.162e+05	9.80	0.0000	0.0168
I:526	952621	1.162e+05	8.20	0.0000	0.0118
I:539	951893	1.162e+05	8.19	0.0000	0.0118
I:540	2.22820e_06	1.162e+05	19.2	0.0000	0.0612
I:541	954814	1.162e+05	8.21	0.0000	0.0118
I:542	954775	1.162e+05	8.21	0.0000	0.0118
I:543	2.16817e+06	1.162e+05	18.7	0.0000	0.0582
I:562	669344	1.162E+05	5.76	0.0000	0.0059

Table 3 Oxymetrics Output – Truncated List

The following are conclusions for significant factors affecting sale values. A similar pattern is seen for the first two variable coefficients listed in Table 4, GRP_NO (Group Number) and the QUAL_CD (Qualification Code). FLDOR uses group numbers for just value analysis while keeping the number of parcels in each group approximately equal. Higher groups are kept for unexpectedly high or low values, and this stratification creates a pattern of higher group number leading to a higher sale price for a parcel (FLDOR 2020 User's Guide). The qualification code represents the type of sale, differentiating between the seller and buyer as well as the interaction of the two. It has a significant and negative coefficient value. The low codes are termed at arm's length sales, while higher codes denote an increased interaction between the buyer and seller. Arm's length interactions try to find maximum value for both parties and drive up sales price, while higher grouped transactions have more familiarity between buyers and sellers and likely end up in some kind of discount between family members or other institutions. It is for this reason that arm's length sales are considered the closest type of transaction to real market value for a property (Weinberger 2011).

The NBRHD_CD (neighborhood code) value is the smallest coefficient with respect to magnitude, but more importantly the smallest partial R^2. This coefficient isn't one of the focuses for the overall impacts since the partial R^2 is the second smallest of all of the coefficients, meaning that is has very little explanatory power in the model and therefore of sales prices overall. The coefficient for the SALE_YR (Sale Year) is positive, capturing an increase in home value from 2018 to 2019. This straightforward increase falls in line with valuations that estimate a roughly 3-5 % annual appreciation rate for homes (Miller 2013). Of note, regional characteristics can significantly alter that rate but no changes significant enough to the study area changed prices drastically from this established trend.

The JV (just value) coefficient was close to one, meaning that the sale price moves closely with changes in the just value. Sales prices have many more considerations then do the home valuations. The leads me to believe that value assessments of appraisal offices in the five counties are representative of the market operations and important to establishing parcel valuation. Additionally, this variable has the most explanatory power as it has the highest partial R^2 for the model, nearly triple the next closest coefficient. The TV_SD (Taxable Value – School District) coefficient is also positive. This value is based on the just value assessment of the parcel after taking away tax exemptions such as homestead, Save our Homes, or other qualifications. A higher TV_SD value does not inherently mean that the JV or the sales price will increase because different programs or annual changes can affect exemption rates. Additionally, in looking through the relationship between the JV and the TV_SD, many parcels in the data set did not have exemptions, and the two numbers were equal. Changes in JV will drive TV_SD, but the opposite is not always true, it follows that TV_SD would not have a large impact if changed alone. Also, the JV corresponded to a strong majority of the sales price variance with the largest R^2 while the TV_SD is one of the smallest, supporting that much of it is explained by the JV

I anticipated that both TOT_LVG_AR (total living area) and NO_BULDNG (number of buildings) would increase value of a parcel if increased, but the coefficient was negative for each. Although they are different in size the variables are two of the most significant with respect to explaining the variance in the sales prices. The model can account for outliers, but the data can still be affected by parcels of unique characteristics. If there are multiple parcels with large areas and multiple buildings that were sold at high prices, decreasing the lot size and number of buildings to one, which was most of the data, could result in a pattern that makes it look like more buildings or area push value down. Additionally, differences in farms or large homesteads to small single building parcels is likely affected by proximity to coast and prices that value location rather than size. Farther away from the coast you will likely see changes in the average land use to more rural or farming or areas that have more land. Similar trends are seen in cities such as Boston, where smaller apartments in the city (lower number of bedrooms and living area) are much more expensive than larger houses outside of the city, but still within the same county.

After exploring the data for the number of buildings, I believe that four parcels are affecting these negative coefficients significantly. Four parcels were found with four buildings on each, the first was a farmstead that was sold for $225,000 (under the average sale price for the data set) and the other three were sales with holding values of $100.00. Although valued much higher, these holding sales prices explain the result that was different than expected. Additionally, a pattern was found where total living decreased as you got closer to city centers such as Tampa in Hillsborough county, coinciding with an opposite pattern of just value decreasing while moving along the same axis. Although there are locations that break the trend such as South Tampa, and the North Tampa lake country where there were big and expensive houses, the pattern exited throughout most of the county. The total living area variable had the fifth highest R^2 of the fourteen variables kept by the model

Counterintuitively, the model left out number of bedrooms as a significant variable to sale price. Although unexpected, the capability to turn living space into a bedroom temporarily through actions such as utilizing pull-out beds, futons or couches, and inflatable mattresses can decrease the value on specific bedroom space. A 2003 paper establishing hedonic price models for single family homes established the relationship and includes bathrooms and living area but leaves out a variable specific for bedrooms themselves (Thibodeau 2003). A similar study conducted focusing on water quality impacts on housing value in Martin County in 2013 did not consider bedrooms, but rather number of bathrooms and total housing square footage. Interestingly, this study also found that demographic description in the area was insignificant although they limited their data set to only waterfront properties (Bin 2013).

Of the three community services provided, only distance to schools and distance to police stations were significant but with opposite magnitudes. Increasing distance away from a school raised prices, but away from a police station dropped prices. A study conducted in 2017 termed the effects that police station have as economic tension due to both the services provided such as response time to emergencies and support in contrast with negative issues such as traffic, congestion, and noise (Dronyk-Trosper 2017). Additional to these direct effects that services provide, analysis of crime impacts is known to affect residential property prices as well (Lens 2016). A study from across the country after a significant decrease in crime rates throughout the 1990s established property values increasing approximately 7-19 % (Pope Crime and property values: Evidence from the 1990s crime drop 2012). Specific examples find relationships between crimes per capita, property crimes, and sexual offender registries increasing, all pushing property values down (Thaler 1978, Gibbons 2004, Linden and Rockoff 2008). These patterns support the negative coefficient value seen in our model, showing that in this case the proximity to support and emergency services outweigh potential colocation of crime, and distance away from a police station is not beneficial to price. With respect to the distance to schools variable, two main factors of proximity to water and the focus of those parcel sales on other qualities. Studies do quantify the positive impact of proximity to schools and the performance of those school (Figlio and Lucas 2004). However, state structure and changes in state laws decrease the value put on proximity to schools. The state of Florida only has one school district for each county, and 48.79 percent of the funding for schools is taken through local effort (FLDOE 2020/2021). Additionally, House Bill 7029 established a new rule where you can school whatever school or district you want, as long as you provided the transportation. These structural characteristics, as well as the underlying effects of an aging population without kids in grades K-12, retirees continuing to flood popular coastal areas, and the prioritization of coastal properties farther away from schools all validate the small but positive coefficient.

Three statistics from two considered distances for k.brev concentrations were found to be significant. Brevissum5km, or the sum of all statistics at a distance of 5 km, and therefore the largest number for each 5km buffer, was the smallest of the brevis values kept as significant with respect to its partial R^2

value. Visual inspection of the buffer rings created leads me to believe that the proximity to water is outweighing brevis values. Within the data set, a value of zero meant that there was no brevis values or that the sold parcel was not within that distance to a value. It seems that many buffers of 1km were not found to have brevis values, and proximity to water is overpowering high brevis values within 5km distance when considering counties as a whole. This is expected when considering the size of the counties as hundreds of square kilometers and the low explanatory value of the variable to sales price.

Two values at a distance of 10 km were kept as significant but had relatively low partial R^2 values. Brevismax10km, had a positive coefficient, while Brevisrange10km had a negative coefficient. I believe there is still an important deduction from these two values that identifies a negative impact on housing prices from the presence of brevis. Although the maximum value seen should increase as the range increases, having a maximum value alone doesn't affect the range directly. From this model specification, although a low maximum value at 10km would have a positive impact (likely from presence of a water-based value meaning presence of water within that distance) it doesn't inherently match what a large range of values would imply. Large ranges of values at 10 km was slightly higher than the coefficient for the max values, which at a low value coincides with the effect of nearby water, but at higher ranges of brevis values (worse blooms) this small difference could be quantified to a significant change in price. Importantly, these values were significant across five counties on both the western and eastern coasts of the state. This strongly indicates that brevis specifically does affect housing prices in these counties and that our findings can be applied and expanded to other regions or taken more specifically to a single county or areas. It must be highlighted that this impact is smaller than expected. From discussion with locals to the state, it seemed clear that the impact was obvious and large but my data shows that home buyers are relatively insensitive to the brevis values, but that the range in values is the most significant variable. Conditions changing from expected to unexpected are having the largest affect to housing prices. Considerations for future research follow in the next section and will include tying these results into improving coastal resiliency and looking for ways to improvement future research.

Since this study only used monthly data over a couple of years, this leads to an assumption that the market fluctuations are being affected by karenia brevis and other water quality measures overall, and less on specific instances of blooms or not on a micro scale (Florida Realtors). Establishing long term efforts to understand longer scale efforts would be extremely beneficial to understand future housing market performance and trends.

With the results from this project, a beneficial relationship between the discussed technologies for satellite remote sensing techniques and this project could be established. With established ties between the HABs and housing sales, improved HAB prediction techniques could benefit the housing market. Predictability in potential changes in housing prices could be important information for appraisers, consumers, and sellers alike which would increase economic resilience and stability to coastal communities. Stroming et al. quantified a benefit to human health of approximately $370,000 USD via improved satellite data for predicting algal blooms, I believe the benefits could be many times over this from benefits received in anticipating the timeframes or locations that HABs could impact the housing market in years to come (Stroming 2020).

Increasing spatial resolution to a singular county would provide a couple of benefits. In dealing with only one county the problem of trying to find consistent attribute data across five different county offices wouldn't limit the characteristics able to be used in the analysis. Additionally, limiting the location and increasing the time frame analyzed could prove beneficial to catch more HAB events and a greater variation in concentrations found. Increasing the number of sales considered or the type of land use code will give more of a chance to catch the sales considered closer to the water and highlight the impacts of brevis concentrations and blooms. Additionally, studies such as this one are helpful in establishing the fact that there is a significant relationship and that further efforts are warranted. Future studies could be continued at the county level and incorporated into the appraisal processes to refine the effects for blooms on each individual county and improve estimation and valuation of sales prices.

Lastly, although housing prices affect less people than do weather patterns, regional climate changes, or long lasting global environmental trends, they are more explainable. Changes in housing prices means more to the average person than does the Keeling Curve or complicated RCPs. Understanding more externalities to climate change that affect more people directly will garner much attention if communicated appropriately and internalized by the general population.

SECTION 4 CONCLUSION

With the direct and indirect effects of toxics contextualized the next step is to use that information to identify both actions and solutions. This last section analyzes the right level of action and explores unique ways of effectively communicating these scientific topics to the public. This begins with an analysis of regulations to understand Florida's published guidance and actions. It is important to put state perspective against both subordinate governmental and federal levels. Understanding appropriate echelons for different actions is important to maximize both effectiveness and efficiency. Ensuring efforts of science and policy are appropriately communicated to the public is extremely important to sustainable progress to improved coastal resiliency.

Establishing state level implementation where appropriate will provide an aggressive and capable level of government where the national government is too big and slow, and it will move the minute and detailed execution of policy down to smaller and more efficient levels for execution. The state needs to do what only the state can in creating and coordinating policy for creating coastal resiliency; progress into the next century must be because of the state level actions, not despite them. Since 2007 Florida has taken climate change into significant focus with Governor Charlie Crist's Executive Order 07-128 and creation of the Governor's Action Team on Energy and Climate Change, but this document mainly outlines a focus on energy use and efforts towards the lowering emissions and climate change mitigation. One of the large failures at the state policy level was not matching this order with a separate order that prioritizes Florida's ability to adapt with the effects of climate change. Within this order the governor identifies global climate change as an important issue for the state and that it will impact "businesses, public infrastructure and disturb the way of life enjoyed by millions of Floridians," (Office of the Governor 2007). With all of that risk it did not mandate a way to start adapting to climate change. Although not distinctly outlined, the Action Team provided a working group to climate change adaptation which provides the base for Florida's state policy, luckily filling the gap in the mandate. In 2010 The Florida Oceans and Coastal Council published an updated look into the effects of climate change on Florida and they again focus on mitigation as a long-term solution. Although adaptation strategies are mentioned, none are described or recommended with any detail. After years from the initial recommendations state level agencies still weren't coming to detailed planning and implementation of adaptation and dealing with already felt impacts (Governor's Action Team 2015).

Other Florida leaders have consistently pushed back. Richard Scott served as Florida governor from 2011 to 2019 until his 2018 election to serve as a Senator (Office of the House Historian 2020). When commenting on the United States' withdrawing from the 2015 Paris Agreement, he was quoted by the Miami Herald that he believes Paris "was clearly not focused on American jobs" (Mazzei 2017). He offered no insight into the problem of climate change nor it's impacts on his state, and only focused on obscure facts to be in line with his party affiliation. At a time when we need to move towards more aggressive and collective action against climate change, he was heading in the wrong direction. His actions without doubt had significant and negative impacts on climate change adaptation progress in the state for almost a decade after its initial focus in 2007.

Despite this state level preoccupation, there are examples of success as well. Feliciano and Prosperi point towards Florida's successful growth management planning system. They reference the 2008 House Bill 697 which follows Broward County's lead. This House Bill will have four different elements focusing on future land use, housing, transportation, and conservation. Examples of specifics from HB697 will be limits on building codes, zoning, or land use measures as likely tools to enhance climate change adaptability (Feliciano 2011). Their analysis highlights Broward County's ability to be carbon neutral, despite lack of regional political structure to oversee efforts. If the three most populous counties are in this region, their collective actions and impacts must be a state level problem, but Feliciano's research prove a lack of overarching structure to support any efforts coming from this important region. They also identify that while Broward County is an established leader in climate change prevention and action, that the municipality level is still an area of weakness in combating climate change (Feliciano 2011). As the state must do what only the state can do, also the lower levels of echelon government must act where the state can't in establishing the direct relationship with the populace and effecting action and lifestyle perspectives. Although Broward County is continuing to be successful despite structure and support, work needs to be done so more areas and cities can follow suite.

The state's improved ability to be the enforcement authority and hold the capability to oversee regional operations at the state level is vitally important. Even with systems where regional action pre-empts state action, such as the successes seen in the Broward County area, state should get involved to share structure and formally adopt it across the state. These systems will fail at state levels without any state capability to weigh in and provide structure. Compiling the people to inspect enough of the systems or facilities, the knowledge and technical expertise to create criteria for inspections, and the legal authority to enforce necessary corrections at the state level must be of higher focus moving forward. Without enforcement, the ruse of high standards can potentially be more dangerous than lower standards, because their good intent can create the image of a more effective system. We cannot allow these violations to continue without correction, one example alone endangers thousands of people's health with unacceptable drinking water for years and is just one of the approximately 146,597 PWSs across the country. I recommend improving the ability of the state through prioritization and funding, or by requesting increased funding from the federal level, to handle the problem by expanding inspectors and state-run support programs to improve the state's water. The hard science and actions taken by governments need to be internalized by the communities they will benefit.

In addition to its water supply Florida will continue to encounter a large problem in the application and structure of deciding how the state government should (or can) control coastal actions as we progress into times of greater risk and more unknowns. Specifically, the issues of land rights versus state rights will be of increased importance as the shoreline shifts and moves. Should people who have land rights to areas that will likely be inundated, or even destroyed, still get to rebuild in the same spot? What are the new limits to coastal zoning areas, and how are those areas supported by public support personnel? If the state can't limit someone from rebuilding in areas of known inundation and they are severely flooded – can there be a discussion of sending first responders to potentially risk their lives to save someone who consciously made that decision? This will be a continuing argument of personal rights and state control and needs to be handled delicately. They are already fighting a similar battle, as storms and winds have moved sand, beachfront private property and beach front public property are coming together.

The case Trepanier v. County of Volusia in 2007 is a stark example of how one effect from climate change will change and challenge legal precedents and policy currently in place. This case brought efforts of conservation of endangered sea turtles using habitat conservation zones into conflict with public versus private landowner rights and beach access customs. Because the public had custom of using the area of the beach for access, and in this specific case the land was not eroded but taken in a single event/storm, the landowners lost their suit against the county in attempt to get them to stop using their land for parking. Although, through the use of custom, the individual landowners lost this case, it was found that custom would need to be proved in each case of this conflict so the state will continue to battle increasingly complicated and large litigation cases as SLR and storms continue to batter the coasts (Malek 2013, Lancaster 2008, Court of Appeals of Florida 2007). Similar battles will affect the economies of coastal cities. How does the state or local governments make prudent decisions on economic activities and urban growth that will prevent people from increasing exposure risks to the effects of climate change, while at the same time continue to develop economically and provide opportunity for business and individuals to profit and grow safely? I recommend that the state move quickly to provide updated legal structure before the problem expands. Getting ahead of these legal battles will protect the state, it's constituents, benefit the environment, and prevent costly and timely legal battles in the future.

One of the main matters is the investment of money in preparing for the future, rather than remaking past mistakes. Many areas are not appropriately funding for disaster relief, a mistake in the face of increased storminess and storm severity on top of sea level rise. Many studies have shown that investing now in climate change adaptation infrastructure will benefit in the long run both economically and environmentally. Hurricane Michael was a Category 5 hurricane that ravaged the state in 2018. The hurricane left areas of significant importance to the country and our military neutralized as they waited for money.

Specifically, it decimated Tyndall Air Force Base near Panama City, Florida. The base didn't have the funds themselves to begin rebuilding immediately and requested $500 million to pay for repairs and to rebuild damages, which is more than Bay County had spent on removing the debris from the hurricane alone (Duehren 2019). After such a large investment, where will the money come from the next time Tyndall is flooded and destroyed, or any other of the twenty military bases, over fifty military reserve units, and 82,000 acres of federally owned military land (FLNG 2020). That is also just looking at the military, which was only portion of the services, industries, and people affected by Hurricane Michael. How many times can you rebuild? Much more funding needs to be put into the Florida Disaster Fund at the state level to help with these acute costs, and the continuing costs of building to prevent future damage and improve adaptation and resiliency.

Another policy tool that needs to be strengthened is commonly known as the AAA, or the Adaptation Action Areas within the 2011 Community Planning Act. Broward County again is a leader in this realm as they formally discouraged development in these areas, rather than just making it an option (Florida Senate 2011). I recommend that at the state level the EPA designates standards that will define AAAs based on consolidated analysis of sea level rise, risk to exposure, horizontal proximity to water, and vertical distance to the mean high water line. These designations will enforce non-optional building restrictions and developmental limits to this area. It will be executed and enforced through the municipal and local level of government and violations will incur high financial punishment. All funds collected through the enforcement of AAAs will establish a state fund that will be used to feed back into the system where I have identified monetary needs such as enforcement of the SDWA and EPCRA, hiring more workers, or investment into green and renewable energy technology.

Palm and Bolson conducted surveys of 1,000 Florida resident's to analyze thoughts on climate change and how to best communicate issues with the general population. First, they found that displaying maps of flooded areas to the survey participants actually made it less likely that they would say that they believe in climate change. They also found that the political affiliation chosen by a participant had the most impact on the likelihood that they would respond that they didn't believe in climate change. Part of the problem with climate change adaptation is to connect the policy to the action. Instead, we connect policy to people (presidents, democrats, republicans, scientists, etc.), which is a problem. They also state that "successful public policy can only be enacted and supported with the concurrence of the majority of the population and the advocacy of its leaders." (Palm 2020). The problem then is how do we appropriately inform the public, inspire their collective action, and persuade leaders that it's the right thing to do?

Although Florida is a coastal state, many of the sub regional characteristics will cause different responses to different areas of the state. Problems vary throughout the state to potential reactions and impacts from climate change. The Everglades region will be an area of general carbon neutrality and with development and management could provide a carbon (C) sink providing benefit to the region, but their worry is sea level rise. Whereas areas such as Miami will feel the effects on their drinking water before worrying about significant areas of the city being permanently inundated (Malone 2015). Combinations of emissions effects due to land use, sea level rise relative to geographic location, and the effects of the beaches drive each city and region's priorities to adaptation – this is not a one size fits all solution that the state can implement. A majority of the Florida Keys have average elevations within 1.5 meters of sea level, well below what the IPCC has as its worst-case scenario for the distance of vertical sea level rise (Flugman 2012).

Communications between officials or organizations with the data needed to understand and solve these problems and the general population must increase and improve. Utilization of newer and better technology to push information to the public, rather than just make it available, is needed. Through social media platforms and phone/computer applications there are many ways to make adaptation policy decisions and topics for input much more visual in our daily lives. I recommend that each municipal and local government create a phone application that notifies the users of important information. Many people get their daily news from social media platforms, online magazines or papers, or even social media influencers. The unfortunate structure of highlighting the popular themes and people as more dependable or trustworthy those professionals in science or policy can be taken advantage of to a good cause. Focuses of climate change adaption can be promulgated in easy to digest articles, posts, and blogs with access to expanded information. Additionally, these messages need to be pulled as far away from identification with a political party as possible. As Palm and Bolson showed us, if people view a problem through their political party it changes their perception. This is a significant result of the increased bipartisan divide that is continually growing in the United States. One of the most dangerous issues we face is influential people with passionate support, promulgating the wrong information. We want people to view the problem through the lens of cooperation, teamwork, and betterment for all, regardless of what party they claim to be a part of. Continued approaches along political lines will stymy progress and exacerbate the increasingly large divide within the country along political lines. Information is key, and we must use new technologies and social habits to communicate well.

In conclusion the state of Florida has many obstacles to overcome in order to construct resilient and sustainable ways to move forward. The concept of sustainability must be the foundation that flows through all efforts. Acting in a non-sustainable way through the burning of fossil fuels, deforestation, consumption levels well above what is necessary, and misunderstanding the effects of our actions on the global system are what got us to this point. Ignoring the scientifically sound observations of human effects on our climate for decades has put us on the edge of changes that we may not be able to reverse or rectify.

If we do not adapt in a sustainable way then we will continue to fuel the problem, rather than provide solutions. Through cooperation at echelon, informed and engaged public citizens, and policy that prioritizes healthy environment rather than profit, we will be successful. Better identification of the direct and indirect impacts that toxic substances have in Florida improves understanding the complexity of the problem as well as our ability to establish solutions and communicate them effectively. This project established weaknesses within the state of Florida in enforcing federal legislation that is focused on protecting human and environmental health. It found that the SDWA is not providing water that meets its standards and ECPRA reporting is occurring, but the risk is high for potential toxic releases, and we aren't doing enough to prevent them. HABs are significantly affecting housing prices in at least five coastal communities. These are problems that we need to begin to remedy immediately. We must take these findings and work towards wide dissemination and understanding of the problems. We must improve our drinking water, minimize anthropogenic degradation of the environment through toxic pollution, and predict future economic impacts of a degrading environment in order to ensure a freasible and sustainable approach to their solution and our future.

APPENDIX 1 FULL IMPULSE LIST – OXYMETRIC OUTPUT

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I:103	-567237.	1.161e+05	-4.88	0.0000	0.0042
I:129	4.63562e+06	1.161e+05	39.9	0.0000	0.2204
I:131	4.63926e+06	1.161e+05	40.0	0.0000	0.2207
I:359	4.60986e+06	1.161e+05	39.7	0.0000	0.2185
I:391	4.63526e+06	1.161e+05	39.9	0.0000	0.2203
I:451	1.13968e+06	1.162e+05	9.80	0.0000	0.0168
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I:539	951893.	1.162e+05	8.19	0.0000	0.0118
I:540	2.22820e+06	1.162e+05	19.2	0.0000	0.0612
I:541	954814.	1.162e+05	8.21	0.0000	0.0118
I:542	954775.	1.162e+05	8.21	0.0000	0.0118
I:543	2.16817e+06	1.162e+05	18.7	0.0000	0.0582
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I:563	1.33244e+06	1.162e+05	11.5	0.0000	0.0228
I:564	1.39181e+06	1.162e+05	12.0	0.0000	0.0248
I:565	1.39215e+06	1.162e+05	12.0	0.0000	0.0248
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I:689	-308050.	1.161e+05	-2.65	0.0080	0.0012
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I:872	321479.	1.162e+05	2.77	0.0057	0.0014
I:874	-377414.	1.162e+05	-3.25	0.0012	0.0019
I:876	733703.	1.162e+05	6.31	0.0000	0.0070
I:879	-498339.	1.162e+05	-4.29	0.0000	0.0033
I:882	-322962.	1.161e+05	-2.78	0.0054	0.0014
I:884	-344577.	1.161e+05	-2.97	0.0030	0.0016
I:885	-469839.	1.161e+05	-4.05	0.0001	0.0029

I:894	-919126.	1.183e+05	-7.77	0.0000	0.0106
I:904	-438404.	1.161e+05	-3.78	0.0002	0.0025
I:909	-382907.	1.166e+05	-3.28	0.0010	0.0019
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I:952	-7.52831e+06	1.322e+05	-57.0	0.0000	0.3653
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I:955	-453446.	1.162e+05	-3.90	0.0001	0.0027
I:956	-432981.	1.162e+05	-3.73	0.0002	0.0025
I:957	-407102.	1.161e+05	-3.51	0.0005	0.0022
I:958	-514252.	1.171e+05	-4.39	0.0000	0.0034
I:959	-501340.	1.162e+05	-4.32	0.0000	0.0033
I:961	-410192.	1.162e+05	-3.53	0.0004	0.0022
I:963	-495316.	1.161e+05	-4.27	0.0000	0.0032
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I:1050	-397734.	1.161e+05	-3.43	0.0006	0.0021
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I:1063	-613555.	1.163e+05	-5.28	0.0000	0.0049
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I:1096	458533.	1.162e+05	3.95	0.0001	0.0028
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I:1176	-449149.	1.162e+05	-3.87	0.0001	0.0026
I:1186	-2.11180e+06	1.171e+05	-18.0	0.0000	0.0545
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I:1193	-453016.	1.162e+05	-3.90	0.0001	0.0027
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I:1231	-820796.	1.163e+05	-7.06	0.0000	0.0088
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I:1745	-474016.	1.161e+05	-4.08	0.0000	0.0029
I:1751	-330077.	1.161e+05	-2.84	0.0045	0.0014
I:1761	-417290.	1.161e+05	-3.59	0.0003	0.0023
I:1766	-352887.	1.161e+05	-3.04	0.0024	0.0016
I:1791	-387619.	1.161e+05	-3.34	0.0009	0.0020
I:1793	-495001.	1.162e+05	-4.26	0.0000	0.0032
I:1795	-350154.	1.161e+05	-3.01	0.0026	0.0016
I:1796	-343982.	1.161e+05	-2.96	0.0031	0.0016
I:1797	-609810.	1.162e+05	-5.25	0.0000	0.0049
I:1803	-440242.	1.161e+05	-3.79	0.0002	0.0025
I:1809	-794785.	1.163e+05	-6.83	0.0000	0.0082
I:1834	-550363.	1.168e+05	-4.71	0.0000	0.0039
I:1835	-1.12463e+06	1.164e+05	-9.66	0.0000	0.0163
I:1840	-421423.	1.164e+05	-3.62	0.0003	0.0023
I:1848	-335820.	1.162e+05	-2.89	0.0039	0.0015
I:1849	-323967.	1.161e+05	-2.79	0.0053	0.0014
I:1855	-386134.	1.161e+05	-3.33	0.0009	0.0020
I:1862	-311261.	1.162e+05	-2.68	0.0074	0.0013
I:1870	-335362.	1.162e+05	-2.89	0.0039	0.0015
I:1873	-434259.	1.161e+05	-3.74	0.0002	0.0025
I:1881	-322101.	1.165e+05	-2.76	0.0057	0.0014
I:1896	-389438.	1.161e+05	-3.35	0.0008	0.0020
I:1915	-890669.	1.165e+05	-7.65	0.0000	0.0103
I:1916	-387342.	1.162e+05	-3.33	0.0009	0.0020
I:1917	-411515.	1.162e+05	-3.54	0.0004	0.0022
I:1919	-347118.	1.162e+05	-2.99	0.0028	0.0016

I:1920	-318263.	1.162e+05	-2.74	0.0062	0.0013
I:1924	-308158.	1.162e+05	-2.65	0.0080	0.0012
I:1943	-622845.	1.162e+05	-5.36	0.0000	0.0051
I:1951	-456003.	1.162e+05	-3.93	0.0001	0.0027
I:1958	-339362.	1.161e+05	-2.92	0.0035	0.0015
I:1964	-316604.	1.161e+05	-2.73	0.0064	0.0013
I:1965	-378330.	1.162e+05	-3.26	0.0011	0.0019
I:1973	639264.	1.164e+05	5.49	0.0000	0.0053
I:1984	944006.	1.164e+05	8.11	0.0000	0.0115
I:1993	-1.14692e+06	1.169e+05	-9.81	0.0000	0.0168
I:1994	-572630.	1.162e+05	-4.93	0.0000	0.0043
I:1996	-1.62530e+06	1.166e+05	-13.9	0.0000	0.0333
I:2001	-949691.	1.163e+05	-8.17	0.0000	0.0117
I:2002	-382946.	1.161e+05	-3.30	0.0010	0.0019
I:2004	-377082.	1.161e+05	-3.25	0.0012	0.0019
I:2017	-490635.	1.162e+05	-4.22	0.0000	0.0031
I:2023	-561482.	1.162e+05	-4.83	0.0000	0.0041
I:2024	-339454.	1.161e+05	-2.92	0.0035	0.0015
I:2030	-1.60324e+06	1.170e+05	-13.7	0.0000	0.0322
I:2032	-1.86326e+06	1.172e+05	-15.9	0.0000	0.0429
I:2051	-713885.	1.230e+05	-5.80	0.0000	0.0059
I:2052	-7.55788e+06	1.477e+05	-51.2	0.0000	0.3170
I:2055	-5.97016e+06	1.248e+05	-47.8	0.0000	0.2887
I:2058	-345909.	1.162e+05	-2.98	0.0029	0.0016
I:2060	315237.	1.162e+05	2.71	0.0067	0.0013
I:2063	306882.	1.162e+05	2.64	0.0083	0.0012
I:2064	-369398.	1.161e+05	-3.18	0.0015	0.0018
I:2065	-505365.	1.161e+05	-4.35	0.0000	0.0033
I:2066	333674.	1.163e+05	2.87	0.0041	0.0015
I:2070	-444165.	1.162e+05	-3.82	0.0001	0.0026
I:2080	-459352.	1.162e+05	-3.95	0.0001	0.0028
I:2081	-530350.	1.161e+05	-4.57	0.0000	0.0037
I:2085	-823618.	1.163e+05	-7.08	0.0000	0.0088
I:2092	-401874.	1.161e+05	-3.46	0.0005	0.0021
I:2094	317811.	1.162e+05	2.73	0.0063	0.0013
I:2100	849423.	1.162e+05	7.31	0.0000	0.0094
I:2112	-941309.	1.163e+05	-8.09	0.0000	0.0115
I:2120	-1.88613e+06	1.167e+05	-16.2	0.0000	0.0443
I:2127	-322897.	1.161e+05	-2.78	0.0054	0.0014
I:2132	-768185.	1.162e+05	-6.61	0.0000	0.0077
I:2135	-379788.	1.161e+05	-3.27	0.0011	0.0019
I:2139	-380821.	1.161e+05	-3.28	0.0010	0.0019
I:2151	-1.35062e+06	1.165e+05	-11.6	0.0000	0.0233
I:2152	-320608.	1.161e+05	-2.76	0.0058	0.0014

I:2156	-406998.	1.161e+05	-3.51	0.0005	0.0022
I:2158	-830503.	1.162e+05	-7.15	0.0000	0.0090
I:2162	1.21466e+06	1.163e+05	10.4	0.0000	0.0190
I:2163	1.18666e+06	1.163e+05	10.2	0.0000	0.0181
I:2164	1.20339e+06	1.165e+05	10.3	0.0000	0.0186
I:2165	1.90650e+06	1.163e+05	16.4	0.0000	0.0455
I:2166	1.63876e+06	1.165e+05	14.1	0.0000	0.0339
I:2167	1.03244e+06	1.165e+05	8.86	0.0000	0.0137
I:2170	1.07376e+06	1.165e+05	9.22	0.0000	0.0149
I:2176	-546095.	1.161e+05	-4.70	0.0000	0.0039
I:2180	622526.	1.166e+05	5.34	0.0000	0.0050
I:2181	600065.	1.165e+05	5.15	0.0000	0.0047
I:2192	-326224.	1.161e+05	-2.81	0.0050	0.0014
I:2193	1.36796e+06	1.162e+05	11.8	0.0000	0.0240
I:2205	-909721.	1.204e+05	-7.55	0.0000	0.0100
I:2211	-388505.	1.161e+05	-3.35	0.0008	0.0020
I:2212	-441659.	1.161e+05	-3.80	0.0001	0.0026
I:2218	-765460.	1.165e+05	-6.57	0.0000	0.0076
I:2219	-1.14275e+06	1.167e+05	-9.79	0.0000	0.0167
I:2229	-420920.	1.162e+05	-3.62	0.0003	0.0023
I:2232	-496319.	1.164e+05	-4.26	0.0000	0.0032
I:2233	-421349.	1.162e+05	-3.63	0.0003	0.0023
I:2235	-419828.	1.162e+05	-3.61	0.0003	0.0023
I:2239	325409.	1.162e+05	2.80	0.0051	0.0014
I:2241	-513729.	1.161e+05	-4.42	0.0000	0.0035
I:2242	1.02771e+06	1.182e+05	8.70	0.0000	0.0132
I:2244	-359965.	1.162e+05	-3.10	0.0020	0.0017
I:2249	-567573.	1.162e+05	-4.88	0.0000	0.0042
I:2253	-554739.	1.162e+05	-4.77	0.0000	0.0040
I:2261	-382324.	1.162e+05	-3.29	0.0010	0.0019
I:2267	-1.62353e+06	1.173e+05	-13.8	0.0000	0.0328
I:2269	356797.	1.164e+05	3.07	0.0022	0.0017
I:2270	-471819.	1.162e+05	-4.06	0.0000	0.0029
I:2274	-388692.	1.163e+05	-3.34	0.0008	0.0020
I:2276	-341429.	1.162e+05	-2.94	0.0033	0.0015
I:2278	-475449.	1.163e+05	-4.09	0.0000	0.0030
I:2280	-304719.	1.161e+05	-2.62	0.0087	0.0012
I:2294	-505202.	1.162e+05	-4.35	0.0000	0.0033
I:2298	-349056.	1.164e+05	-3.00	0.0027	0.0016
I:2300	-316995.	1.163e+05	-2.73	0.0064	0.0013
I:2309	-518738.	1.162e+05	-4.46	0.0000	0.0035
I:2328	-439564.	1.163e+05	-3.78	0.0002	0.0025
I:2341	-312181.	1.161e+05	-2.69	0.0072	0.0013
I:2344	-536922.	1.163e+05	-4.62	0.0000	0.0038

I:2366	-531392.	1.166e+05	-4.56	0.0000	0.0037
I:2367	-642557.	1.167e+05	-5.51	0.0000	0.0053
I:2369	-314702.	1.164e+05	-2.70	0.0069	0.0013
I:2390	-470239.	1.162e+05	-4.05	0.0001	0.0029
I:2394	-410522.	1.162e+05	-3.53	0.0004	0.0022
I:2428	-371398.	1.163e+05	-3.19	0.0014	0.0018
I:2431	-405491.	1.162e+05	-3.49	0.0005	0.0022
I:2455	-374497.	1.162e+05	-3.22	0.0013	0.0018
I:2486	-551772.	1.167e+05	-4.73	0.0000	0.0040
I:2489	-415489.	1.162e+05	-3.58	0.0004	0.0023
I:2491	-359726.	1.164e+05	-3.09	0.0020	0.0017
I:2497	-622806.	1.164e+05	-5.35	0.0000	0.0051
I:2509	-363811.	1.165e+05	-3.12	0.0018	0.0017
I:2513	-325408.	1.162e+05	-2.80	0.0051	0.0014
I:2534	-447732.	1.162e+05	-3.85	0.0001	0.0026
I:2568	-450693.	1.162e+05	-3.88	0.0001	0.0027
I:2583	-341802.	1.161e+05	-2.94	0.0033	0.0015
I:2585	-558938.	1.164e+05	-4.80	0.0000	0.0041
I:2606	-412738.	1.164e+05	-3.55	0.0004	0.0022
I:2610	-319956.	1.162e+05	-2.75	0.0059	0.0013
I:2611	-614817.	1.163e+05	-5.29	0.0000	0.0049
I:2617	-332944.	1.162e+05	-2.87	0.0042	0.0015
I:2643	-477278.	1.163e+05	-4.10	0.0000	0.0030
I:2663	886162.	1.162e+05	7.62	0.0000	0.0102
I:2680	1.83308e+06	1.162e+05	15.8	0.0000	0.0422
I:2683	1.83729e+06	1.162e+05	15.8	0.0000	0.0424
I:2689	-365170.	1.163e+05	-3.14	0.0017	0.0017
I:2690	520531.	1.167e+05	4.46	0.0000	0.0035
I:2695	1.83287e+06	1.162e+05	15.8	0.0000	0.0422
I:2707	-501393.	1.180e+05	-4.25	0.0000	0.0032
I:2709	-414627.	1.161e+05	-3.57	0.0004	0.0023
I:2722	-350344.	1.161e+05	-3.02	0.0026	0.0016
I:2736	5.78055e+06	1.181e+05	48.9	0.0000	0.2980
I:2747	1.10832e+06	1.163e+05	9.53	0.0000	0.0158
I:2761	-491259.	1.163e+05	-4.22	0.0000	0.0032
I:2803	1.31935e+06	1.185e+05	11.1	0.0000	0.0215
I:2804	769808.	1.164e+05	6.62	0.0000	0.0077
I:2823	671043.	1.165e+05	5.76	0.0000	0.0059
I:2972	4.34832e+06	1.161e+05	37.4	0.0000	0.1991
I:3015	-495891.	1.163e+05	-4.27	0.0000	0.0032
I:3051	-336884.	1.162e+05	-2.90	0.0038	0.0015
I:3102	-436004.	1.163e+05	-3.75	0.0002	0.0025
I:3104	-384732.	1.162e+05	-3.31	0.0009	0.0019
I:3145	-403339.	1.163e+05	-3.47	0.0005	0.0021

I:3174	-360517.	1.162e+05	-3.10	0.0019	0.0017
I:3180	1.76563e+06	1.162e+05	15.2	0.0000	0.0393
I:3184	-2.23488e+06	1.171e+05	-19.1	0.0000	0.0606
I:3185	-2.85519e+06	1.181e+05	-24.2	0.0000	0.0939
I:3196	2.43146e+06	1.162e+05	20.9	0.0000	0.0720
I:3200	-345924.	1.162e+05	-2.98	0.0029	0.0016
I:3205	-372985.	1.162e+05	-3.21	0.0013	0.0018
I:3208	-338327.	1.161e+05	-2.91	0.0036	0.0015
I:3216	-1.43503e+06	1.170e+05	-12.3	0.0000	0.0260
I:3221	-466330.	1.162e+05	-4.01	0.0001	0.0028
I:3226	-733021.	1.164e+05	-6.30	0.0000	0.0070
I:3232	-773876.	1.202e+05	-6.44	0.0000	0.0073
I:3233	-3.48769e+06	1.191e+05	-29.3	0.0000	0.1320
I:3242	-667084.	1.162e+05	-5.74	0.0000	0.0058
I:3243	-327903.	1.161e+05	-2.82	0.0048	0.0014
I:3245	-302930.	1.161e+05	-2.61	0.0091	0.0012
I:3251	-1.07890e+06	1.216e+05	-8.87	0.0000	0.0138
I:3254	-462586.	1.162e+05	-3.98	0.0001	0.0028
I:3257	-374667.	1.161e+05	-3.23	0.0013	0.0018
I:3269	-782396.	1.164e+05	-6.72	0.0000	0.0080
I:3274	340544.	1.166e+05	2.92	0.0035	0.0015
I:3276	589343.	1.166e+05	5.06	0.0000	0.0045
I:3299	2.48722e+06	1.163e+05	21.4	0.0000	0.0750
I:3300	795505.	1.165e+05	6.83	0.0000	0.0082
I:3310	-429499.	1.162e+05	-3.70	0.0002	0.0024
I:3312	497279.	1.208e+05	4.12	0.0000	0.0030
I:3316	-1.52978e+06	1.170e+05	-13.1	0.0000	0.0294
I:3324	356508.	1.169e+05	3.05	0.0023	0.0016
I:3327	-793400.	1.164e+05	-6.82	0.0000	0.0082
I:3328	-664321.	1.163e+05	-5.71	0.0000	0.0057
I:3329	6.52178e+06	1.163e+05	56.1	0.0000	0.3579
I:3330	6.50664e+06	1.163e+05	55.9	0.0000	0.3568
I:3331	2.46616e+06	1.163e+05	21.2	0.0000	0.0738
I:3333	360871.	1.163e+05	3.10	0.0019	0.0017
I:3339	-430378.	1.161e+05	-3.71	0.0002	0.0024
I:3341	-723976.	1.167e+05	-6.20	0.0000	0.0068
I:3343	-396053.	1.161e+05	-3.41	0.0007	0.0021
I:3344	-573508.	1.162e+05	-4.94	0.0000	0.0043
I:3360	-372319.	1.162e+05	-3.21	0.0014	0.0018
I:3375	1.30051e+06	1.161e+05	11.2	0.0000	0.0218
I:3410	-355476.	1.162e+05	-3.06	0.0022	0.0017
I:3434	-698169.	1.162e+05	-6.01	0.0000	0.0064
I:3436	-366498.	1.161e+05	-3.16	0.0016	0.0018
I:3509	-447650.	1.162e+05	-3.85	0.0001	0.0026

I:3510	-509685.	1.162e+05	-4.39	0.0000	0.0034
I:3518	-660541.	1.162e+05	-5.69	0.0000	0.0057
I:3532	-2.13115e+06	1.169e+05	-18.2	0.0000	0.0557
I:3537	-799354.	1.162e+05	-6.88	0.0000	0.0083
I:3541	-361345.	1.161e+05	-3.11	0.0019	0.0017
I:3616	-1.11439e+06	1.163e+05	-9.59	0.0000	0.0160
I:3636	427652.	1.163e+05	3.68	0.0002	0.0024
I:3650	-793431.	1.166e+05	-6.81	0.0000	0.0081
I:3652	-1.45401e+06	1.166e+05	-12.5	0.0000	0.0269
I:3704	419949.	1.165e+05	3.60	0.0003	0.0023
I:3711	384384.	1.162e+05	3.31	0.0009	0.0019
I:3715	1.78092e+07	1.162e+05	153.	0.0000	0.8063
I:3716	1.78089e+07	1.162e+05	153.	0.0000	0.8063
I:3717	1.78087e+07	1.162e+05	153.	0.0000	0.8063
I:3733	1.75130e+07	1.163e+05	151.	0.0000	0.8009
I:3773	-418199.	1.161e+05	-3.60	0.0003	0.0023
I:3775	-414309.	1.163e+05	-3.56	0.0004	0.0022
I:3777	-899827.	1.164e+05	-7.73	0.0000	0.0105
I:3785	-740986.	1.162e+05	-6.38	0.0000	0.0072
I:3814	418483.	1.165e+05	3.59	0.0003	0.0023
I:3841	950519.	1.162e+05	8.18	0.0000	0.0117
I:3848	331908.	1.161e+05	2.86	0.0043	0.0014
I:3880	528638.	1.177e+05	4.49	0.0000	0.0036
I:3881	-695280.	1.164e+05	-5.98	0.0000	0.0063
I:3882	-919424.	1.166e+05	-7.88	0.0000	0.0109
I:3900	1.56358e+06	1.163e+05	13.4	0.0000	0.0311
I:3942	-579830.	1.163e+05	-4.98	0.0000	0.0044
I:3943	-403772.	1.162e+05	-3.47	0.0005	0.0021
I:3944	-409756.	1.161e+05	-3.53	0.0004	0.0022
I:3948	-594266.	1.162e+05	-5.11	0.0000	0.0046
I:3949	-839996.	1.164e+05	-7.22	0.0000	0.0092
I:3951	-359751.	1.161e+05	-3.10	0.0020	0.0017
I:3952	-497330.	1.163e+05	-4.28	0.0000	0.0032
I:3965	-360212.	1.161e+05	-3.10	0.0019	0.0017
I:4000	-446872.	1.161e+05	-3.85	0.0001	0.0026
I:4003	-419960.	1.161e+05	-3.62	0.0003	0.0023
I:4010	360204.	1.162e+05	3.10	0.0020	0.0017
I:4150	668306.	1.162e+05	5.75	0.0000	0.0058
I:4155	1.47179e+06	1.162e+05	12.7	0.0000	0.0277
I:4169	398417.	1.163e+05	3.43	0.0006	0.0021
I:4181	-331599.	1.161e+05	-2.86	0.0043	0.0014
I:4186	-357145.	1.162e+05	-3.07	0.0021	0.0017
I:4207	-366713.	1.161e+05	-3.16	0.0016	0.0018
I:4378	1.60458e+06	1.161e+05	13.8	0.0000	0.0328

I:4380	-347077.	1.162e+05	-2.99	0.0028	0.0016
I:4382	-324511.	1.162e+05	-2.79	0.0053	0.0014
I:4400	3.25807e+06	1.161e+05	28.1	0.0000	0.1224
I:4403	448848.	1.161e+05	3.87	0.0001	0.0026
I:4415	7.94551e+06	1.164e+05	68.3	0.0000	0.4527
I:4423	573640.	1.164e+05	4.93	0.0000	0.0043
I:4433	-346005.	1.161e+05	-2.98	0.0029	0.0016
I:4440	-575468.	1.162e+05	-4.95	0.0000	0.0043
I:4450	-401526.	1.163e+05	-3.45	0.0006	0.0021
I:4452	-320074.	1.162e+05	-2.75	0.0059	0.0013
I:4466	-330434.	1.161e+05	-2.85	0.0045	0.0014
I:4474	-427421.	1.164e+05	-3.67	0.0002	0.0024
I:4490	-467137.	1.162e+05	-4.02	0.0001	0.0029
I:4491	3.11588e+06	1.162e+05	26.8	0.0000	0.1131
I:4499	-502520.	1.163e+05	-4.32	0.0000	0.0033
I:4503	-512866.	1.162e+05	-4.41	0.0000	0.0034
I:4506	-372287.	1.161e+05	-3.21	0.0014	0.0018
I:4543	313730.	1.167e+05	2.69	0.0072	0.0013
I:4585	3.68718e+06	1.163e+05	31.7	0.0000	0.1513
I:4592	498941.	1.163e+05	4.29	0.0000	0.0033
I:4608	1.27915e+06	1.164e+05	11.0	0.0000	0.0210
I:4610	1.27307e+06	1.164e+05	10.9	0.0000	0.0208
I:4645	3.08463e+06	1.162e+05	26.5	0.0000	0.1111
I:4661	-929043.	1.166e+05	-7.97	0.0000	0.0111
I:4672	-425119.	1.161e+05	-3.66	0.0003	0.0024
I:4680	-438556.	1.162e+05	-3.77	0.0002	0.0025
I:4695	-571336.	1.162e+05	-4.92	0.0000	0.0043
I:4702	-579953.	1.162e+05	-4.99	0.0000	0.0044
I:4747	387891.	1.161e+05	3.34	0.0008	0.0020
I:4764	-375185.	1.161e+05	-3.23	0.0012	0.0018
I:4765	-726656.	1.163e+05	-6.25	0.0000	0.0069
I:4793	-779862.	1.164e+05	-6.70	0.0000	0.0079
I:4812	-339642.	1.161e+05	-2.93	0.0035	0.0015
I:4831	-750405.	1.162e+05	-6.46	0.0000	0.0073
I:4854	-481928.	1.161e+05	-4.15	0.0000	0.0030
I:4873	-484841.	1.162e+05	-4.17	0.0000	0.0031
I:4877	-455894.	1.162e+05	-3.92	0.0001	0.0027
I:4914	347285.	1.163e+05	2.99	0.0028	0.0016
I:5040	-804056.	1.162e+05	-6.92	0.0000	0.0084
I:5045	-3.85296e+06	1.194e+05	-32.3	0.0000	0.1559
I:5046	-823718.	1.162e+05	-7.09	0.0000	0.0088
I:5052	-359054.	1.161e+05	-3.09	0.0020	0.0017
I:5053	-791365.	1.163e+05	-6.81	0.0000	0.0081
I:5055	-972340.	1.164e+05	-8.35	0.0000	0.0122

I:5058	-876198.	1.163e+05	-7.53	0.0000	0.0100
I:5061	-1.25994e+06	1.164e+05	-10.8	0.0000	0.0204
I:5062	-1.12476e+06	1.164e+05	-9.67	0.0000	0.0163
I:5064	-470213.	1.162e+05	-4.05	0.0001	0.0029
I:5066	-398238.	1.161e+05	-3.43	0.0006	0.0021
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I:5134	367010.	1.197e+05	3.06	0.0022	0.0017
I:5137	-676302.	1.224e+05	-5.52	0.0000	0.0054
I:5140	-7.80081e+06	1.309e+05	-59.6	0.0000	0.3863
I:5143	-739217.	1.168e+05	-6.33	0.0000	0.0071
I:5150	-385513.	1.165e+05	-3.31	0.0009	0.0019
I:5152	-509267.	1.162e+05	-4.38	0.0000	0.0034
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I:5164	-527338.	1.161e+05	-4.54	0.0000	0.0036
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I:5181	-531489.	1.162e+05	-4.58	0.0000	0.0037
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I:5190	-622345.	1.162e+05	-5.36	0.0000	0.0051
I:5195	-353559.	1.161e+05	-3.04	0.0023	0.0016
I:5201	-423061.	1.236e+05	-3.42	0.0006	0.0021
I:5202	-507246.	1.161e+05	-4.37	0.0000	0.0034
I:5208	-438026.	1.162e+05	-3.77	0.0002	0.0025
I:5211	-455270.	1.167e+05	-3.90	0.0001	0.0027
I:5213	-470406.	1.161e+05	-4.05	0.0001	0.0029
I:5218	-375971.	1.161e+05	-3.24	0.0012	0.0019
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I:5221	376012.	1.163e+05	3.23	0.0012	0.0019
I:5223	-355967.	1.161e+05	-3.07	0.0022	0.0017
I:5228	-823419.	1.162e+05	-7.09	0.0000	0.0088
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I:5237	-424299.	1.161e+05	-3.65	0.0003	0.0024
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I:5299	-484599.	1.161e+05	-4.17	0.0000	0.0031
I:5300	-582067.	1.161e+05	-5.01	0.0000	0.0044
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I:5306	561767.	1.162e+05	4.83	0.0000	0.0041
I:5313	-475467.	1.161e+05	-4.09	0.0000	0.0030
I:5322	-416512.	1.161e+05	-3.59	0.0003	0.0023
I:5333	-449512.	1.161e+05	-3.87	0.0001	0.0026
I:5338	-534412.	1.161e+05	-4.60	0.0000	0.0037
I:5370	-383952.	1.162e+05	-3.30	0.0010	0.0019
I:5378	-700993.	1.161e+05	-6.04	0.0000	0.0064
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I:5380	-586569.	1.162e+05	-5.05	0.0000	0.0045
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I:5531	-324088.	1.161e+05	-2.79	0.0053	0.0014
I:5533	-529838.	1.161e+05	-4.56	0.0000	0.0037
I:5534	-378415.	1.161e+05	-3.26	0.0011	0.0019
I:5536	-535042.	1.168e+05	-4.58	0.0000	0.0037
I:5537	-336910.	1.161e+05	-2.90	0.0037	0.0015
I:5579	-405506.	1.161e+05	-3.49	0.0005	0.0022
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I:5703	-1.36769e+06	1.164e+05	-11.7	0.0000	0.0239
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I:5738	-1.92846e+06	1.172e+05	-16.5	0.0000	0.0458

I:5744	433180.	1.168e+05	3.71	0.0002	0.0024
I:5745	-396053.	1.167e+05	-3.39	0.0007	0.0020
I:5746	629818.	1.169e+05	5.39	0.0000	0.0051
I:5747	-403326.	1.167e+05	-3.46	0.0006	0.0021
I:5752	-360403.	1.164e+05	-3.10	0.0020	0.0017
I:5753	-348273.	1.164e+05	-2.99	0.0028	0.0016
I:5757	-331479.	1.161e+05	-2.86	0.0043	0.0014
I:5774	-357369.	1.161e+05	-3.08	0.0021	0.0017
I:5801	-300312.	1.161e+05	-2.59	0.0097	0.0012
I:5808	-464664.	1.161e+05	-4.00	0.0001	0.0028
I:5812	-441538.	1.161e+05	-3.80	0.0001	0.0026
I:5820	-435898.	1.161e+05	-3.75	0.0002	0.0025
I:5933	401445.	1.161e+05	3.46	0.0005	0.0021
I:6075	-381017.	1.162e+05	-3.28	0.0010	0.0019
I:6107	-308626.	1.161e+05	-2.66	0.0079	0.0013

```
sigma                   116061  RSS             7.59585831e+13
                log-likelihood       -80731.8
no. of observations       6194  no. of parameters          555
mean(SALE_PRC)          241545  se(SALE_PRC)            603327

      AR 1-2 test:      F(2,5637) =   3.6393 [0.0263]*
       ARCH 1-1 test:    F(1,6192) =   3.6668 [0.0556]
      Normality test:   Chi^2(2)  =   378.45 [0.0000]**
      Hetero test:      F(27,5625)=   44.966 [0.0000]**
      RESET23 test:     F(2,5637) =   6.4869 [0.0015]**
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